CIVIL TILTROTOR APPLICATIONS RESEARCH

HEARING

BEFORE THE

SUBCOMMITTEE ON TRANSPORTATION,
AVIATION AND MATERIALS

OF THE

COMMITTEE ON
SCIENCE, SPACE, AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

ONE HUNDRED FIRST CONGRESS

SECOND SESSION

JULY 17, 1990

[No. 155]

Printed for the use of the
Committee on Science, Space, and Technology

U.S. GOVERNMENT PRINTING OFFICE
35-269 ⇆ WASHINGTON : 1990

For sale by the Superintendent of Documents, Congressional Sales Office
U.S. Government Printing Office, Washington, DC 20402

H701-13

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

ROBERT A. ROE, New Jersey, *Chairman*

GEORGE E. BROWN, Jr., California
JAMES H. SCHEUER, New York
MARILYN LLOYD, Tennessee
DOUG WALGREN, Pennsylvania
DAN GLICKMAN, Kansas
HAROLD L. VOLKMER, Missouri
HOWARD WOLPE, Michigan
BILL NELSON, Florida
RALPH M. HALL, Texas
DAVE McCURDY, Oklahoma
NORMAN Y. MINETA, California
TIM VALENTINE, North Carolina
ROBERT G. TORRICELLI, New Jersey
RICK BOUCHER, Virginia
TERRY L. BRUCE, Illinois
RICHARD H. STALLINGS, Idaho
JAMES A. TRAFICANT, Jr., Ohio
LEE H. HAMILTON, Indiana
HENRY J. NOWAK, New York
CARL C. PERKINS, Kentucky
TOM McMILLEN, Maryland
DAVID E. PRICE, North Carolina
DAVID R. NAGLE, Iowa
JIMMY HAYES, Louisiana
DAVID E. SKAGGS, Colorado
JERRY F. COSTELLO, Illinois
HARRY JOHNSTON, Florida
JOHN TANNER, Tennessee
GLEN BROWDER, Alabama

ROBERT S. WALKER, Pennsylvania*
F. JAMES SENSENBRENNER, Jr., Wisconsin
CLAUDINE SCHNEIDER, Rhode Island
SHERWOOD L. BOEHLERT, New York
TOM LEWIS, Florida
DON RITTER, Pennsylvania
SID MORRISON, Washington
RON PACKARD, California
PAUL B. HENRY, Michigan
HARRIS W. FAWELL, Illinois
D. FRENCH SLAUGHTER, Jr., Virginia
LAMAR SMITH, Texas
JACK BUECHNER, Missouri
CONSTANCE A. MORELLA, Maryland
CHRISTOPHER SHAYS, Connecticut
DANA ROHRABACHER, California
STEVEN H. SCHIFF, New Mexico
TOM CAMPBELL, California
JOHN J. RHODES, III, Arizona

Robert C. Ketcham, *Chief of Staff*
John S. Doyle, Jr., *Chief Counsel*
Carolyn C. Greenfeld, *Chief Clerk*
David D. Clement, *Republican Chief of Staff*

Subcommittee on Transportation, Aviation and Materials

ROBERT G. TORRICELLI, New Jersey, *Chairman*

DAN GLICKMAN, Kansas
DAVE McCURDY, Oklahoma
BILL NELSON, Florida
TOM McMILLEN, Maryland
GEORGE E. BROWN, Jr., California
(Vacancy)

TOM LEWIS, Florida
CHRISTOPHER SHAYS, Connecticut
DANA ROHRABACHER, California
TOM CAMPBELL, California

---

*Ranking Republican Member.

CONTENTS

WITNESSES

Page

July 17, 1990:
- Hon. Pete Geren, a Representative in Congress from the State of Texas..... 2
- Hon. Curt Weldon, a Representative in Congress from the State of Pennsylvania 13
- Morris Flater, President, Hubexpress Airlines, Stow, Massachusetts; John Finley, Managing Director, Feeder Aircraft Operations, Federal Express Corp.; and James Muldoon, Director, Aviation Technical Services, Port Authority of New York and New Jersey 29
- Edward Renouard, Executive Vice President, Boeing Helicopters; Leonard Horner, President, Bell Helicopter Textron, Inc.; and Cliff McKeithan, Director of External Affairs, Georgia Institute of Technology and Director, NASA/DOD/FAA Tiltrotor Study 68
- Joseph Del Balzo, Executive Director for System Development, FAA; and Robert Rosen, Deputy Associate Administrator for the Office of Aeronautics, Exploration, and Technology, NASA 134

CIVIL TILTROTOR APPLICATIONS RESEARCH

TUESDAY, JULY 17, 1990

House of Representatives,
Committee on Science, Space, and Technology,
Subcommittee on Transportation, Aviation and Materials,
Washington, D.C.

The subcommittee met, pursuant to call, at 2:10 p.m., in Room 2318, Rayburn House Office Building, Hon. Robert G. Torricelli, [chairman of the subcommittee] presiding.

Mr. Torricelli. The committee will come to order, please.

Today, the subcommittee will convene to consider a technology that has the potential to affect in a profound and enduring way the future of air transportation, and indeed, the continuing leadership of the United States in this important international field.

There has been only a handful of such technologies in the history of aviation. Those that understood their importance and had the vision to undertake their development were rewarded with many years of unchallenged market dominance. Boeing's bet-the-company strategy for development of the 707 is by far the best internationally known example.

Today, we'll be examining the civil benefits of tiltrotor, a technology with the potential to change aviation in a profound way every much as the 707 did for a previous generation.

Yet, despite its promise, and I believe obvious advantages to the nation, the tiltrotor is at a crossroad. The DOD project to develop. a military version has been proposed for termination. This is extremely important because virtually all major advances in aviation in this country have had a military technological precursor. That is also unlikely to change in the near term.

The B-47 and B-52 bombers, developed in the late '40s and early '50s, served such a role for the 707, giving potential customers some hard data about operational costs, especially maintenance costs of a large swept-wing aircraft with jet engines.

The V-22 can serve exactly such a function for tiltrotor technology.

During this hearing, the subcommittee will examine this notion further, as well as other factors involved in inducing manufacturers to develop and users to buy a revolutionary new aircraft. The other important aspect of tiltrotor commercialization is the issue of infrastructure. The full benefits of this technology can only be realized if it has separate air space and separate landing facilities, both of which require action by governmental entities, and the need for which each of those were a very real reason for us hosting this hearing and involving this committee.

Unfortunately, the FAA, for its part, has allocated funds only for type certification, using results of the V-22. Very little has been done to determine vertiport requirements and the complex procedural changes in the air traffic system needed to allow the tiltrotor to operate from city-center to city-center free of conventional traffic. Further effort will also be needed to characterize the noise and congestion benefits of tiltrotor usage.

To discuss these issues today, we've assembled three panels, representing potential users, manufacturers and government. I look forward to hearing from each of them as they discuss this technology, some of these challenges that are before us. It is a timely opportunity with consideration of the future of the V-22 before the Congress in only a matter of days and weeks, and indeed, with this committee already beginning to take action to force the FAA to begin considering some of these congestion landing infrastructure questions as well.

To begin, if we could hear from two distinguished Members of the House, Curt Weldon, and Pete Geren. Gentlemen, thank you for joining us today. We will be joined by a number of our colleagues shortly who are enroute, however, without—unless you object, I'd like to proceed now, if we could.

Pete, would you like to proceed?

STATEMENT OF HON. PETE GEREN, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF TEXAS

Mr. GEREN. Sure.

Thank you, Mr. Chairman, and I want to commend you for holding these hearings and helping Congress to explore this revolutionary technology and the opportunities that it presents to us as a country and the needs we have in it, not only militarily, but in the civil aviation applications.

My colleague, Curt Weldon, has long been a strong supporter and leader in the fight for the V-22 and Curt will talk about the military application. We have heard over the last several months testimony from, particularly the Marines, but from experts in and out of government, talking about the importance militarily of this technology.

Curt will go into that in great detail, but I just want to mention one development. Our Secretary of Defense has long been a critic of the V-22 program. He has said repeatedly that he thought the technology was supportable, commended the program, said we couldn't afford it. Last—or two weeks ago, the Department of Defense released a study that was performed by the Institute for Defense Analysis which has refuted that—that problem that the Secretary had with the problem. It has shown that the V-22 is cost-effective; that the V-22 can fit in the budget parameters that the Secretary himself has laid out, and that with the V-22, we get bang for the bucks, so to speak.

It is—it should put the military arguments against it to bed once and for all. Unfortunately, it has not, and we continue to have to argue and we are all thankful to the leadership that Curt Weldon has given in that pursuit.

I want to talk about the civilian application and I ask unanimous consent to submit a further statement to the record—

Mr. Torricelli. Without objection, it will be entered in the record.

Mr. Geren. —and I would like to summarize my remarks.

I serve on the Aviation Subcommittee and earlier this year, we also held hearings on the need for the tiltrotor technology. We heard from experts around the country, people who spoke for the need for the V-22 from around the world. The V-22 program is following the traditional path towards commercial application that we have seen in every major aviation advance in this country and that has made the United States preeminent in aviation and aviation-related technology.

NASA pioneered this technology in the fifth—1950s, with the XV-3, the experimental XV-15 and now, Department of Defense is developing this technology for military use. The V-22 could be certified by 1993 and a pressurized derivative could be certified by 1996.

In April, we were fortunate in having the prototype, XV-15, land on the steps of the Capitol. That day, we got to glimpse—a glimpse of the future. Many Members of Congress and thousands of people from around the country gathered in front of the Capitol and we got to see that revolutionary aircraft demonstrate its capabilities in front of the Capitol.

We are here today to explore why this technology is so important. We have proven—the people who have developed it, NASA, in partnership with the Department of Defense and private industry—has brought this technology right to the doorstep of the future. We are now at a critical juncture.

Are we going to go ahead or are we going to back away from it and let someone else do it? The studies, the performance of this revolutionary aircraft has demonstrated its application in so many areas of civilian life. The military special operations, in addition to the conventional military uses for which it was developed—they have testified that it's critical to their mission.

Another area that has become a military mission—certainly it is of critical importance to everybody in this country, and particularly those in civilian law enforcement, is the field of drug interdiction. Right now, drug interdiction of international drug trafficking takes three aircraft. You need a surveillance aircraft, you need a chase aircraft, and then you hope that they're going to land close enough to some helicopter pad that a helicopter can come in and land and interdict the shipment.

Realistically, that doesn't happen very often, to have all three of those components fit together. With the V-22, you could have surveillance, you could have tracking, and you could land wherever they happen to land to try to dispose of their shipment. So, for drug interdiction, it would be the ideal aircraft.

Disaster relief. With the Hurricane Hugo, the earthquake in Mexico City, both clear examples of how this technology could allow us to have saved human life. We could have avoided human misery and could have brought critical relief during the critical time period after each of those disasters. With Hurricane Hugo, we had to wait to see if those airports were open and could take the landing of traditional aircraft. With the disaster with the earthquake in Mexico City, the same problem. It took many hours before we could ever get critical supplies in to those people who were suffering and needed immediate relief.

In both cases, the V-22 could have offered instant relief to those people in need.

Fire-fighting, another example where V-22 could go longer distances, could carry firefighters and fire-fighting equipment into forest fires or into remote areas where fire-fighting was necessary.

Medical evacuation. Commercial delivery services. Other cases where the uses would be obvious. And one other that's particularly of interest to us in Congress today, over the last several years, we've struggled with oil spills, oil spill technology and oil spill response. The V-22 is the perfect airplane for the oil spill problems that we face right now. Oil spills happen in unconvenient locations, places miles away from people and the equipment necessary to clean up the spills and to address the spills.

The Valdez, the Mega Borg, in both cases, our Coast Guard and private industry could have used the V-22 to respond much more quickly to those spills to save the cost of the spill and also saved our environment from irreparable damage. There are as many applications of the V-22 in civilian life as our imagination can—can offer.

One area of critical—of particular importance to those of us on the Aviation Subcommittee is air transportation infrastructure. We are having an increasingly difficult time meeting the infrastructure needs of our transportation industry. Every 10 years, we're doubling the number of people that fly in America. Expansion of our existing infrastructure is very expensive.

Dallas/Ft. Worth Airport in my area is going to spend $3.5 billion to expand to meet the needs of the traveling public in that area. Denver is about to spend $2.5 billion building a new airport, and even when the money is available, in many cases the expansion is very difficult to effect because of the opposition of neighbors, because of the noise pollution, because of the growth in and around these airports—make it very difficult for them to expand.

The V-22 would enable these existing airports and also provide air service in rural areas, allow them to meet the transportation needs of those areas without having to spend the billions of dollars on infrastructure.

A four-area tract would allow a large city to meet its short-haul transportation needs. It would enable the big airports in this country to meet much of the problem they have with meeting the demands on their system.

One of the biggest problems in expanding our existing infrastructure is the objections to the noise that we hear from the people that live in and around the airports. The V-22 already meets the stage three aircraft noise levels. A V-22 could fly in and out of DFW Airport, LaGuardia Airport, the neighbors wouldn't know it came in, the neighbors wouldn't know it left.

In so many ways, by its versatility, by the noise levels, by its capability that conventional aircraft, neither helicopters nor traditional airplanes can meet. The V-22 is the aircraft of the future.

The FAA testified in front of our committee. They didn't talk about if we have tiltrotor technology, if we have vertical take-off and landing technology, they talked about when. So we in Congress are faced with the big question. Is it going to be the United States that is going to use this as another example of America remaining preeminent in the area of aviation technology, an area that, I want to add, is one of the very few areas we maintain a positive balance of trade, or are we going to let it slip overseas? We have spent over $2 billion of taxpayers' money on this concept, hundreds of millions of dollars of private industry money and it would be a shame if we stood by and let foreign companies, through the hiring of American scientists and American engineers, to take that several billion dollars' worth of taxpayers' investment in this country and turn it into jobs and a technology that would end up producing a product that we would be buying here in this country.

The Minister of Trade for Japan summed it up very well when he visited the Bell plant in the district that I represent. He watched the aircraft take off; he watched it maneuver; he saw the many things that it was capable of doing. I am sure he let his imagination run wild as he thought about the congestion problems and the transportation problems that they have in their country and he said, flatly, "If you build it, we'll buy it. If you don't build it, we will."

I am pleased to be here today. I urge this committee to favorably consider this revolutionary technology and help us make sure that this remains American technology and it produces an American product that produces tens of thousands of American jobs and helps America to stay the preeminent power when it comes to aviation industry.

Mr. Chairman, thank you for letting me appear before you today.

[The prepared statement of Mr. Geren follows:]

July 17, 1990

STATEMENT OF CONGRESSMAN PETE GEREN
ON TILTROTOR TECHNOLOGY
SUBCOMMITTEE ON TRANSPORTATION, AVIATION AND MATERIALS

GOOD MORNING MR. CHAIRMAN AND MEMBERS OF THE SUBCOMMITTEE.

I APPRECIATE THE OPPORTUNITY TO APPEAR BEFORE THE SUBCOMMITTEE TODAY AND WITH THE OTHER WITNESSES TO DISCUSS THE TILTROTOR TECHNOLOGY.

THIS HEARING IS VERY IMPORTANT BECAUSE IT WILL FOCUS ATTENTION ON THIS STATE-OF-THE-ART AVIATION TECHNOLOGY THAT IS TRULY REVOLUTIONARY. TILTROTOR TECHNOLOGY WILL DEFINITELY BE THE AVIATION TECHNOLOGY OF THE TWENTY-FIRST CENTURY.

TODAY WE WILL HEAR TESTIMONY FROM MANY WITNESSES THAT ARE INVOLVED IN THE DEVELOPMENT OF THIS TECHNOLOGY AND FROM WITNESSES THAT WILL ILLUSTRATE THE MANY APPLICATIONS OF THIS TECHNOLOGY.

AS MANY OF YOU KNOW, THE TILTROTOR TECHNOLOGY THAT IS CURRENTLY UNDER DEVELOPMENT BY THE DEPARTMENT OF DEFENSE, ALLOWS AN AIRCRAFT TO TAKE-OFF AND LAND VERTICALLY LIKE A HELICOPTER YET CONVERT ITS PROPELLORS AND FLY LIKE A HIGH-SPEED AIRPLANE. THIS AIRCRAFT IS CALLED THE V-22 OSPREY.

THE V-22 PROGRAM IS FOLLOWING THE TRADITIONAL PATH TOWARD COMMERCIAL APPLICATION THAT HAS MADE THE U.S. PREEMINENT IN AVIATION AND AVIATION RELATED TECHNOLOGY. NASA PIONEERED THIS TECHNOLOGY IN THE 50's WITH THE XV-3, THE EXPERIMENTAL XV-15 AND NOW DOD IS DEVELOPING THIS TECHNOLOGY FOR MILITARY USE. THE V-22

COULD BE CERTIFIED BY 1993 AND A PRESSURIZED DERIVATIVE COULD BE CERTIFIED BY 1996.

IN APRIL, WE WERE FORTUNATE IN HAVING THE EXPERIMENTAL AIRCRAFT, THE XV-15, AVAILABLE FOR VIEWING ON THE EAST PARKING LOT OF THE CAPITOL FOR MEMBERS, STAFF AND VISITORS TO SEE. IT WAS A VERY IMPRESSIVE DEMONSTRATION THAT MEMBERS ARE STILL TALKING ABOUT.

YOU MAY ASK WHY IS THIS TECHNOLOGY SO IMPORTANT.

THE VERSATILITY AND MANEUVERABILITY OF THIS INNOVATIVE AIRCRAFT MAKE IT IDEALLY SUITED FOR SO MANY MISSIONS, FOR WHICH TRADITIONAL HELICOPTERS OR AIRPLANES ARE IMPRACTICAL.

SOME OF THESE MISSIONS WILL INCLUDE NEW USES FOR THE MILITARY SPECIAL OPERATIONS, DRUG INTERDICTION, DISASTER RELIEF, FIREFIGHTING, MEDICAL EVACUATION, COMMERCIAL DELIVERY SERVICES, AND CIVIL TRANSPORTATION.

ALTHOUGH THE WITNESSES THAT WILL FOLLOW WILL DISCUSS SOME OF THESE EXAMPLES IN GREATER DETAIL, I WOULD LIKE TO MENTION A FEW AT THIS POINT.

THE MARINE CORPS IS A STRONG SUPPORTER OF THE V-22 AND HAS MADE THE V-22 OSPREY ONE ITS HIGHEST PRIORITIES. GENERAL CHARLES PITTMAN, HEAD OF MARINE CORPS AVIATION, DESCRIBED THE TILTROTOR AIRCRAFT AS VITAL EQUIPMENT FOR THE MARINE CORPS. TESTIFYING BEFORE THE HOUSE ARMED SERVICES COMMITTEE, GENERAL PITTMAN STATED THAT "IN THE COMBAT SITUATION, THE SPECIAL FORCES OPERATIONS ... YOU MUST HAVE THIS MODERN TECHNOLOGY. IF YOU DON'T HAVE THAT, YOU'RE GOING TO LOSE A LOT MORE PEOPLE IN TRAINING AND IN PEACETIME OPERATIONS AS WELL AS WARTIME OPERATION". I MENTION THIS QUOTE BECAUSE THE NEEDS OF THE MARINE CORPS FOR THIS TECHNOLOGY REMAINS.

THE V-22 HAS THE CAPABILITY OF FLYING TROOPS AND SUPPLIES DIRECTLY INTO THE THEATER OF ACTION. THE V-22 WOULD ALLOW US TO GO DEEPER INTO THE ACTION THAN A CONVENTIONAL HELICOPTER COULD, AT TWICE THE SPEED. WE WILL BE ABLE TO FLY FURTHER, FASTER AND WITHSTAND FAR GREATER ATTACKS THAN WE ARE CURRENTLY ABLE TO WITHSTAND.

SECRETARY CHENEY AGREES THAT THE V-22 OFFERS "EXTRAORDINARY CAPABILITY" IN HIS WORDS, BUT HE ARGUES THAT EXISTING AIRCRAFT CAN FULFILL THE SPECIAL NEEDS OF THE MARINES AND OTHER MILITARY BRANCHES WHO HAVE BEEN COUNTING ON THE OSPREY. ALTHOUGH THE IDA REPORT PROVED THE V-22 TO BE MORE COST-EFFECTIVE, HE ARGUES THAT THE INVESTMENT COSTS FOR THE V-22 ARE TOO HIGH, THAT FUNDING THE TILTROTOR AIRCRAFT WOULD REQUIRE TOO MUCH OF A TRADE-OFF FOR THE ARMED SERVICES.

MR. CHENEY SHOULD BE COMMENDED FOR HIS COMMITMENT TO REDUCING THE BUDGET DEFICIT. HE UNDERSTANDS THE GRAVITY OF THE THREAT WE FACE FROM THE $12,000 IN DEBT WE HAVE STACKED-UP FOR EVERY MAN, WOMAN, AND CHILD IN THIS COUNTRY. THE BUDGET CRISIS IS A DISEASE WE HAVE IGNORED LONG ENOUGH, AND WE MUST ADMINISTER THE CURE BEFORE IT CONTINUES TO SPIRAL OUT OF CONTROL. BUT, THE V-22 IS PART OF THE ANSWER, NOT PART OF THE PROBLEM.

ON JUNE 29, THE INSTITUTE FOR DEFENSE ANALYSIS, A PENTAGON THINK-TANK, RELEASED ITS LONG-AWAITED STUDY COMPARING THE V-22 WITH

ITS SUPPOSED "ALTERNATIVES". THE STUDY SHOWED THAT THE TILTROTOR AIRCRAFT IS FASTER, MORE VERSATILE, AND IS MORE COST-EFFECTIVE THAN ALL OF ITS CLOSEST COMPETITORS. IN DOING SO, THE IDA STUDY PROVED WHAT OSPREY SUPPORTERS HAVE KNOWN ALL ALONG -- THERE IS NO ALTERNATIVE TO THE V-22 OSPREY.

MR. CHAIRMAN, THE AVIATION SUBCOMMITTEE RECENTLY REPORTED OUT A BILL TO REAUTHORIZE THE FEDERAL AVIATION ADMINISTRATION PROGRAMS THAT THE FULL HOUSE IS EXPECTED TO CONSIDER THIS WEEK. DURING THE HEARINGS ON THIS BILL, WITNESS AFTER WITNESS STRESSED THAT THE MAJOR PROBLEMS CONFRONTING THE FAA ARE TO RESOLVE THE AIR SPACE CAPACITY AND AIR SAFETY ISSUES THAT FACE THE AVIATION INDUSTRY.

WE KNOW THAT THE CONGESTION AND DELAY PROBLEMS THAT WE ARE NOW EXPERIENCING AT OUR MAJOR AIRPORTS WILL ONLY GET WORSE. IT IS ESTIMATED THAT THE U.S. AIR PASSENGER TRAFFIC WILL PROBABLY DOUBLE WITHIN THE NEXT TEN YEARS.

YET, WE ARE LIMITED IN OUR ABILITY TO MEET THIS ADDED GROWTH IN AIR TRAVEL. WE ARE LIMITED BY THE AIR SPACE THAT IS AVAILABLE, BY THE ABILITY TO EXPAND CURRENT AIRPORTS, AND BY OUR ABILITY TO BUILD NEW AIRPORTS, WHERE THE COSTS COULD EASILY EXCEED $5 BILLION.

BUT, HERE IS A PERFECT EXAMPLE WHERE THE TILTROTOR TECHNOLOGY COULD BE UTILIZED. NO RUNWAYS WOULD BE NEEDED TO ACCOMMODATE THIS AIRCRAFT. THIS AIRCRAFT COULD LAND AND DEPART IN THE DOWNTOWN AREA OF ANY CITY. AN URBAN VERTIPORT WOULD ONLY REQUIRE A SMALL AREA, APPROXIMATELY 4.5 ACRES AND THIS WOULD BE SUFFICIENT SPACE TO HANDLE OVER 3,000 PASSENGERS A DAY. ONE VERTIPORT COULD RELIEVE AS MANY AS ONE MILLION PASSENGERS A YEAR FROM AN AIRPORT'S TRAFFIC.

ANOTHER EXAMPLE WHERE THIS TECHNOLOGY IS NEEDED IS IN THE AREA OF DISASTER RELIEF. THIS AIRCRAFT COULD LAND WITHOUT A RUNWAY, GETTING NEEDED SUPPLIES INTO AN AREA MORE QUICKLY. THIS AIRCRAFT COULD HAVE BEEN UTILITIZED DURING THE RECENT HURRICANE HUGO DISASTER THAT HIT THE EAST COAST AND THE EARTHQUAKE THAT HIT CALIFORNIA. ADDITIONALLY, BECAUSE OF THE POTENTIAL SIZE OF THIS AIRCRAFT, IT WOULD BE POSSIBLE TO BRING THE HOSPITAL (MEDICAL EQUIPMENT AND STAFF) TO THE ACCIDENT SITE VERSUS TRANSPORTING THE PATIENT TO THE HOSPITAL.

THIS AIRCRAFT ALSO WOULD GREATLY ASSIST IN THE DRUG INTERDICTION EFFORT BY HAVING AN AIRCRAFT THAT CAN PERFORM THE ENTIRE INTERDICTION MISSION: SURVEILLANCE, PURSUIT, AND APPREHENSION. A MISSION CURRENTLY REQUIRING THREE AIRCRAFT.

ONCE DEVELOPED, THIS TECHNOLOGY WILL ALSO LINK MANY RURAL AREAS OF THIS COUNTRY WITH THE AIR TRANSPORTATION SYSTEM. THIS WILL OPEN UP TREMENDOUS OPPORTUNITIES IN RURAL AREAS BECAUSE OF THE FLEXIBILITY TO ADJUST TO CHANGING TRANSPORTATION NEEDS BY PLANNING VERTIPORTS IN ADVANCE OF POPULATION GROWTH. A TILTROTOR TRANSPORTATION SYSTEM CAN BE USED TO ATTRACT ECONOMIC DEVELOPMENT TO MANY LOW DENSITY AREAS OF THIS COUNTRY.

MR CHAIRMAN, WE HAVE REACHED THE LIMIT OF THE HELICOPTER TECHNOLOGY. WE KNOW ITS MAXIMUM SPEED AND CAPABILITIES. THE SPEED AND TECHNOLOGICAL ADVANCES OF THE TILTROTOR AIRCRAFT ARE UNLIMITED.

THE TILTROTOR AIRCRAFT WILL BE BUILT. THE ONLY QUESTION IS WHETHER IT WILL HAVE "MADE IN THE U.S.A." ON THE HULL OR "MADE IN

JAPAN". EUROPEAN AEROSPACE COMPANIES HAVE FORMED A CONSORTIUM TO DEVELOP THIS TECHNOLOGY WITH THE GOAL OF HAVING AN OPERATIONAL TILTROTOR BY THE YEAR 2000.

JAPAN IS MOVING FROM PLANE ASSEMBLY TO DEVELOPMENT OF VARIOUS AEROSPACE TECHNOLOGIES, INCLUDING ADVANCED WING COMPOSITION. THE ISHIDA GROUP OF JAPAN IS DEVELOPING A TILT-WING AIRCRAFT THAT IS SIMILAR TO THE TILT ROTOR BUT LESS EFFICIENT IN THE HELICOPTER MODE.

ON A RECENT VISIT TO THE BELL-TEXTRON FACILITY IN TEXAS, THE JAPANESE MINISTER OF TRADE, MR. HIKARU MATSUNAGA, SAID OF THE V-22 "IF YOU BUILD IT, WE'LL BUY IT. IF YOU DON'T BUILD IT, WE WILL". MR. CHAIRMAN, WE NEED TO BUILD IT.

I BELIEVE THAT MOST MEMBERS OF CONGRESS WANT TO SEE THIS TECHNOLOGY DEVELOPED HERE IN THE U.S. THE V-22 PROGRAM HAS STRONG BI-PARTISAN CONGRESSIONAL SUPPORT.

THE V-22 OSPREY HAS THE WIDEST SUPPORT OF ANY MILITARY AIRCRAFT IN RECENT MEMORY, SUPPORT THAT TRANSCENDS PARTY LINES. POLITICAL IDEOLOGY, AND REGIONAL BOUNDARIES. MEMBERS OF CONGRESS THAT HAVE NO PAROCHIAL INTEREST IN THE V-22 ARE FIGHTING TO KEEP THE PROGRAM ALIVE. WHY? BECAUSE WHEN THEY LOOK TOWARD THE FUTURE, THEY SEE VISIONS OF THE PAST.

HOW MANY TIMES HAVE WE SEEN TECHNOLOGY DEVELOPED HERE IN THIS COUNTRY, YET END UP BEING MANUFACTURED ABROAD? LOOK AT THE VCR; WE LOST THIS TO JAPAN. WE HAVE LOST THE MAGNETIC LEVITATION SYSTEM TO GERMAN COMPANIES. LET US NOT LOSE TILTROTOR TECHNOLOGY.

AGAIN, MR. CHAIRMAN I WANT TO COMMEND YOU FOR HOLDING THIS HEARING AND FOR INVITING SOME EXCELLENT WITNESSES TO TESTIFY. I LOOK FORWARD TO HEARING THEIR VERY INFORMATIVE TESTIMONY.

Mr. **Torricelli**. Thank you very much.

Curt.

STATEMENT OF HON. CURT WELDON, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF PENNSYLVANIA

Mr. **Weldon**. Thank you, Mr. Chairman. I also would like to commend you and the subcommittee for holding this very critical hearing at a very important time as we begin the defense budget process, both in the House and over in the Senate.

As you're well aware, we're discussing a technology today that's been oftentimes referred to as the biggest single breakthrough in aviation since the jet engine.

I come before you today as someone who is a member of the Armed Services Committee, sits on the Defense Policy Panel, the Seapower Subcommittee, the Research and Development Subcommittee, and also sit on the Merchant Marine and Fisheries Committee, where, in the last session, I was a member of the Coast Guard Subcommittee, so I'm aware of a number of possible uses of the V-22 aircraft and tiltrotor technology by the government beyond just the defense capabilities.

I'm here to talk specifically about the defense posture, what happened, why the program was canceled and what we've done to reverse that decision and why the facts represented to Secretary Cheney were incorrect and have really allowed the Congress to take a very logical course in reversing what Secretary—former Secretary of the Navy, John Lehman, has called the worst decision in the 1990s defense budget process, the decision to cancel and eliminate the V-22.

We are at a critical crossroads in this program, as you stated in your opening statement, because we have been working on this technology for some 30 years, eight years specifically funded by this government to put forth the technology that is at least five years and perhaps as many as 10 years ahead of any of our allies and any other nations that are pursuing the tiltrotor technology.

As Pete has mentioned, both the Japanese and the Europeans, specifically, EUROFAR, have come together and are very aggressively pursuing tiltrotor technology because of the tremendous military and commercial opportunities afforded by this—by this aircraft.

Now it's up to us in the Congress to determine whether or not we will accept the recommendation to move ahead with this aircraft or to allow someone else to produce what we know will eventually be developed.

DOD, on the record, has repeatedly admitted that this aircraft is a good aircraft, the technology is a good technology. They have given two reasons why they want to cancel it. They've said that it's too costly, and they've also said that it's a pork barrel program that is only supported by those Members of Congress in whose districts the program is being developed.

Both of those arguments have been solidly refuted through testimony of DOD officials on the record at hearings, especially before the Armed Services Committee, over the last year. In addition, DOD has held that the mission for the V-22 is too narrow, despite the fact that in 1984, an interoffice memo was sent by Mr. Chu from the Office of Planning and Evaluation that identified over 30 separate military missions that this aircraft could perform, everything from anti-submarine warfare to over-the-horizon to medium lift to amphibious assault and a host of other issues, including those involved with drug interdiction and potential use in emergency response situations.

The Marines, in fact, have been looking for a replacement for their medium-lift needs since 1974. The prototype for the V-22, as you know, was the XV-15, which we had, thanks to the efforts of our good friend, Mr. Oberstar, and Mr. Geren, out on the parking lot of the Capitol building.

The XV-15 stunned people at the Paris Air Show and since the time that the two XV-15s have been flying, people all over the world have seen this technology demonstrated through hundreds of hours of actual testing and flight experience.

The program has received intense scrutiny since the XV-15 and since that point in time where Congress and the administration started jointly funding the development of this aircraft. We've had intense scrutiny from three separate Secretaries of Defense, three Commandants of the Marine Corps, four Service Secretaries and many subsequent Service Secretaries have all looked at this technology, and yet time and again, over the last eight years, the V-22 has been funded because it has remained the top priority of our Marines and the top priority of our Special Operations Forces.

One point that is little understood, and unfortunately, the press has taken a superficial look at this and it bothers me because they've allowed the administration to get away with a very superficial argument that Secretary Cheney is really eliminating a multibillion dollar program. Secretary Cheney has never proposed, ever, eliminating a multi-billion program. He has proposed replacing the V-22 with an alternative program.

Unlike the B-2 and those advocates who would like to kill the program and not have replacement, Secretary Cheney and the people in the Pentagon have proposed replacing the V-22 with a buy—an additional buy of many more helicopters that are existing technology and, in fact, 20-year-old technology.

This older helicopter buy, which would include the H-53 and the H-60, would somehow be connected together in an arrangement that has yet been tested and which has not been proven and, according to the budget people in the Pentagon, would allow us to meet the missions that the Marine Corps have assigned to them.

The problem is that when the Defense Department came before our committee last year and we on the committee were asking about the alternative, we were lead to believe that this really was a serious alternative that was being considered by the Pentagon. In fact, what we found out over the last year is there never was an alternative. It was nothing more than an attempt by the Department of Defense to come up with an argument to allow us in the Congress to accept elimination of this program and to have the Marine Corps accept an alternative that was certainly less than acceptable and, in fact, an alternative that General Gray, the current Commandant of the Marine Corps, before our full committee of the House this year said was ridiculous, and that he would never subject his men to that type of an alternative. It's never been tested and has never been proven.

The reason why the budget people in the Pentagon were able to get the Secretary of Defense's ear was because they were proposing an alternative that would not cost us dollars until five to 10 years down the road. So it really was not cost-savings; it's cost-deferral. What they're proposing is that when you compare the V-22 versus the alternative in the total lifecycle of the programs, the costs are about equal. Yet the costs to fund the V-22, because it's a new aircraft, are upfront; the costs for the alternative buy would not really hit us until five to 10 years down the road.

If we can't find the money for this need and this mission right now, I don't know how they ever expect us to find the money five to 10 years down the road, and in my opinion, it was simply a chance for those people who have had a bias against the V-22 for years to be able to move in and to fill that gap in advising Secretary Cheney to kill the program this year. It is no secret—and I have had this confirmed by everyone from Secretary Lehman to former commandants and people in charge of Marine Corps Aviation, that Mr. Chu, in the Office of Planning and Budget Analysis, consistently has tried to kill the V-22 program during the entire four years that Secretary Lehman was the Secretary of the Navy. He tried repeatedly to get the Secretary to cancel the program, each time, unsuccessfully.

Much as was done with the Harrier program of the Marine Corps, in which case Congress repeatedly put the money back in. The same thing was attempted by Mr. Chu and his shop, to cancel the program. The unfortunate thing was because Secretary Cheney had only been in office for about 28 days, he was relying on his budget people to present alternatives to him to allow him to meet President Bush's financial requirements in the quickest possible period of time.

Therefore, they were able to grab his attention and, therefore, the decision was made, a very short-sighted decision, to cancel the V-22 program. So the decision to cancel the V-22 program, a very important point, was not made by military people. It was made by budget pencil-pushers in the Pentagon who were able to grab this period of time—I think somewhat vulnerable period of time—and convince the Secretary that this was the best choice. Kill the program. We'll worry about the mission later on. We'll worry about the needs of the Marine Corps later on, but let's kill this program now.

We have, over the last year, using DOD's own numbers and own testimony, completely refuted the argument that this program is too costly. And, in fact, through a revised budget analysis that we've put together, working with the Marine Corps and with the contractors, we have come up with an alternative that will allow us to fund the V-22 using the alternative monies that Secretary Cheney placed in this year's budget and in the outyears budget to fund the alternative aircraft to meet this mission.

So it is a point that is often overlooked by the media, but is an important point for us to understand in this institution, that we're talking about two alternatives. We're not talking about one versus nothing, and if you compare the two alternatives, as the IDA study did, and I have a copy of that. If you would like it for the record, I'll provide it to you. The IDA study, commissioned and forced by this Congress, but completed by the Pentagon, independent analysis of the alternatives, clearly said that the V-22 is the best alternative. It's the most cost-effective way to meet the needs for our amphibious assault and our medium-lift capability of the Marines and the Special Forces.

So it totally reinforces everything that we have said over the last year. These are—these are numbers and these are facts that are provided by Department of Defense information, not by contractors, not by us as Members of Congress, but by that information that has been available to the—both the budget people in the Pentagon, as well as our strategic military personnel.

So the cost arguments really are shallow and if you take the IDA study, even using the scaled-down buy of the V-22, to equal the total 20-year cost of the alternative, the recommendation in the study is that you get far more capability, even with the reduced buy, than you would ever get from buying the existing mix of helicopters that Secretary Cheney has proposed.

So the Pentagon's results speak for themselves. Released two weeks ago, they totally support the arguments that we have made and, to be honest with you, I think it's caused a tremendous amount of embarrassment within the Pentagon. Not embarrassment, per se, for Secretary Cheney, because he was relying on advice from his budget people, embarrassment for the people that sold Secretary Cheney and this Congress a bill of goods that was based upon erroneous assumptions.

Let me say that since that point in time, in terms of the cost, we have put the numbers on the table and I think we have answered all the questions in terms of the cost.

An issue that is put forth by the Secretary and by the people who would want us to cut this program deals with the issue of pork, and while there are those that could make the argument that those who are most actively supporting the program have a special interest because it is partially manufactured in their district, I can tell you that the alternative aircraft buy, which is of equal value, approximately $25 billion, happens to be proposed to be manufactured in the State of Connecticut. And I would say if the Secretary fails to talk about the potential pork implications for those people who would stand to benefit from the thousands of jobs that would be created by the additional buy of H-53s and H-60s in that particular district. So if the Secretary or the Pentagon or the administration is going to use the pork argument, you've got to use it on both sides of the equation because they are not talking about eliminating a program. They're talking about putting an alternative in and that's a very important point that people tend to want to overlook quickly.

Let me say that in terms of the issue of military use, there's just no limit to where we can use this aircraft. When you sit before our panelists, as I have on the Armed Services Committee, and this year, we've held at least eight hearings where the V-22 has come up for discussion, and you listen to Secretary—the Commandant of the Marine Corps come in and say that the need is there, this is our number one priority, the medium-lift, the over-the-horizon capability, the amphibious assault, when you see the kind of conflict that our young Marines and Special Forces are going to be asked to go into, whether it's Panama, Grenada, the attempt to rescue hostages in Tehran, or any of the low-intensity conflicts that we know will be there over the next 20 years, there is no alternative than the V-22.

Just recently, I had retired General Smith in from the Marine Corps, who was in charge of Marine Aviation under President Reagan. He told me the story of a situation in Danang in 1965 where approximately 20 of our young Marines were seriously injured in an attack. They were trying to find a way to get medical treatment to them and to get them out quickly. By the time the helicopters that were available at that time arrived and airlifted those men out one at a time, 12 of them died, were unable to be rescued.

The medical officers on the scene at the time and since that point in time have told General Smith that if we would've had the capability of the V-22, we perhaps could have saved every one of those 12 lives. On the record before our committee, numerous military officers from the Marines and the Special Forces, General Lindsay, have said that if we would've had this aircraft in Vietnam, we could have saved hundreds of lives.

General Lindsay, who has been a very capable leader of our Special Operations Forces, has said on the record that if we do without the V-22, it's like sending our young Special Operations Forces into one-man kamikazi runs. That's not the kind of thing that any of us want in this institution in terms of putting forth our young military personnel into hostile environments.

So, in terms of the mission, I think we've been able to completely refute the arguments that the budget people in the Pentagon put forth. I feel somewhat saddened for Secretary Cheney because I think now that he's come to see all the facts and the detailed analyses that have been done by everyone, I think it's evident that we made a bad decision last year. Congress was right in restoring the program.

The Senate has already taken preliminary action in putting R&D money in. That's not enough. This year, in our defense budget, we've asked for $238 million of R&D money and we've asked for a small amount of procurement money, a little bit in excess of $100 million. If we can get that combination of $403 million, we can put the V-22 on track. We can do it within the envelope of the alternative funds proposed by the Secretary, which is a total of $485 million for the medium- and heavy-lift capabilities.

We think, and the members of the Armed Services Committee who are working with this on this issue, think it is the right thing for us to be doing, that as we develop this aircraft, we can bring the costs down. As I look at all the many defense programs that we have, there is no other program that I can point to that has the chance to come down in price per copy. We can't sell a nuclear-powered submarine to Carnival Cruise Lines, and we can't sell the B-2 bomber to TWA. Yet, everyone wants to buy the V-22. That's why the Tiltrotor Coalition today has 150 Members of Congress. That's why every major air transportation company, every major airport authority, has come out in favor of the V-22. That's why former Secretary of Transportation, Drew Lewis, has come out and said, "We made a bad decision. We need to restore this program."

Ross Perot, Donald Trump, all the people interested in the future of aviation in this country, but without the demonstrated capability of a military version, which the Marines desperately need, we're not going to have the chance to prove them right, and more importantly, to bring down the military cost of this aircraft per copy as we develop the commercial use of it down the road 10 and 20 years from now.

So, Mr. Chairman, I think we are on the verge of making a very important decision not just for our military, not just for our Marines, and not just for our Special Forces. This decision will impact America from a competitiveness standpoint. That's why the labor unions, steelworkers, UAW, building trades—that's why retired Marine Reserve offices—that's why all the major independent defense analysis groups in the country, some of the leading conservative think tanks, such as the Center for Security Policy, headed by Frank Gaffney, has said this is the next FSX deal waiting to happen.

All of these people have come together and they have said we made a bad decision last year. It's time to reverse it.

With the assistance of your subcommittee and with the leadership role that you've taken and can take in promoting the commercial application of this, which has been jointly assessed by the FAA, we can't help but be successful this year.

I appreciate the role you've taken. I appreciate your subcommittee's efforts and I look forward to working with you as we restore this vital program for America.

[The prepared statement of Mr. Weldon follows:]

July 17, 1990

Statement by the the Honorable Curt Weldon

Thank you, Mr. Chairman. I appreciate the opportunity to testify before the Subcommittee on a subject of considerable importance to our national security, our national economy and international competitiveness in the aerospace industry -- specifically, tiltrotor technology.

As you will hear from other witnesses today, tiltrotor technology is not a new concept -- it has been in development for over thirty years. However, we have now finessed this technology to the point that it can be effectively used for military missions and many civilian needs.

The development of the Marine's tiltrotor aircraft, the V-22 Opsrey, has enabled us to demonstrate that we can combine the capabilities of a helicopter and a fixed wing plane into an extremely versatile, efficient aircraft. The tiltrotor can fulfill many military missions now hampered by the limited speed and range of helicopters. Some civilian applications, such as short-haul air travel and commercial delivery service transport are also being explored. The full potential of this aircraft is not as much limited by capability as it is by our imagination and creativity.

Now that we have demonstrated the technology, we are at a critical crossroads in tiltrotor development. After years of government investment in tiltrotor technology, the Administration has proposed termination of the most advanced tiltrotor aircraft, the V-22. Congress must now decide if it will accept that recommendation or move ahead with a revolutionary aviation technology to carry us into the next century.

DOD officials admit that the V-22 is a good aircraft and one they would like to have, but they insist we cannot afford it. Efforts to save the program have been tagged with the "pork" label. A close look at the facts reveals the flaws in both arguments.

The Marines have been searching for a medium lift helicopter replacement since 1974. After a successful demonstration of the XV-15 at the Paris Air Show, a decision was made to pursue the tiltrotor for a multi-service medium lift replacement. Thus, the JVX (which later became the V-22) program was initiated, and funded in FY82. The program has received intense scrutiny -- from three Secretaries of Defense, three Commandants, four service secretaries at a critical milestone in 1986, and many subsequent service secretaries since that time. In addition, it received regular reviews by the DOD Comptroller, and five to six Department reviews annually. Finally, the program has been funded annually since 1982, and has enjoyed strong congressional support. So you can imagine how surprised many of us were by the Administration's sudden decision to cancel the V-22 program.

One point which is little understood is that the Administration

is not asking us to eliminate a multi-billion dollar program. They are asking us to choose between the V-22 and an older helicopter program to meet our requirements. They're saying eliminate the V-22, and buy extra helicopters -- hundreds more -- to meet our requirements. EVEN IF YOU ACCEPT THE HIGHEST FIGURES FOR THE V-22 PROGRAM AND THE LOWEST FIGURES FOR THE HELICOPTER ALTERNATIVE PROPOSED BY DOD, WE'RE TALKING ABOUT A FEW BILLION DOLLARS IN SAVINGS -- AND WE WILL STILL BE PAYING BILLIONS OF DOLLARS TO PURCHASE A FORTY-YEAR OLD TECHNOLOGY.

The advantage of the DOD alternative is that it would not require any significant procurement dollars until the end of the decade. V-22, on the other hand, is now ready to go into production, and would require slightly more up front. Yet, designs for the alternative have not even been drafted yet. So, DOD's proposal is not about cost savings, it is about cost deferral. My question is this: If we cannot afford to come up for the money for V-22 now, how will we come up with the funds necessary for the heavy procurement alternative at the end of the decade?

I would like to emphasize a very important point here: the DOD proposal to eliminate the V-22 was not made by military people. It was pushed by DOD budget crunchers, who many have claimed to be opposed to the V-22 program from the outset. Former Secretary of the Navy John Lehman claimed that he had to fight David Chu, the head of the Pentagon's planning, analysis and evaluation shop, every year on the V-22. Insiders will tell you that Mr. Chu has always been out to kill the V-22, and when he got access to a new Secretary who needed to make some quick cuts in 30 days, he got his chance. Unfortunately, budget crunchers do not account for factors such as increased speed, range and survivability, or put a price tag on lives saved when making their decisions.

For that reason, Congress commissioned an independent analysis of the V-22 to consider such factors and determine the value of the V-22 versus its competitors. That study, which was released last week, confirms that the V-22 is the most cost-effective aircraft for amphibious assault and a host of other missions. It confirms that even a reduced buy of V-22s would be more effective, sometimes significantly more so, than the alternatives.

One way or another, we will buy something to fulfill our medium lift requirements. The CH-46 helicopters that we are replacing were bought in the 60s. Whatever we replace it with will be used in hot spots around the globe into the year 2020. We know that we have reached the envelope on helicopter technology, and no matter how much we tinker with it, we can't increase its performance much. The tiltrotor moves us into the next generation of aircraft. That is as relevant to us in the civil world as it is to the military planners.

DOD says that the V-22 is too expensive for the narrow amphibious assault mission. Yet, a 1984 DOD memo lists over thirty missions within each of the services for the V-22. It will be used for amphibious assault, but it will also enable us to stop sending our soldiers into "one-way kamikaze operations," according the former Commander of our special operations forces, General James Lindsay. It will singlehandedly perform the drug interdiction role now handled by three aircraft. Its increased speed and range will greatly improve our search and rescue missions, and may make the difference that saves lives in medivac.

Finally, the aircraft has huge potential for civilian use. I am sure you will hear more on that from your next witnesses. Of course, that is no reason for DOD to buy the aircraft. The reason DOD should buy the aircraft is that the requirements for it remain, and without it, the services will have to pour more money down the hole to develop an alternative.

As civil technology experts, I think you should remember, too, that some of our premier technological breakthroughs came first from the military -- such as the KC-135 that became our nation's commercial airliner, and the jet engine itself. I think the Committee also needs to consider the trade implications of this aircraft: We now know beyond a shadow of a doubt that if we don't build it, foreigners will -- and they will sell it back to us.

Without the V-22, our special operations forces will not be able to meet many of their missions, and the Marines will have an inferior medium lift replacement. It is clear that alternatives will have to come if V-22 production does not. Those who say that V-22 is "pork," must admit that any alternative will be somebody's pork project, with a local constituency and employment opportunities. But V-22 is not just that -- it is an aircraft with huge potential for our nation, and that is why it enjoys such strong bipartisan support nationwide. There are Members representing 33 states now in the Congressional Tiltrotor Technology Coalition.

We have six V-22 aircraft now, with over 200 hours of flight test time. Until program monies were recaptured by DOD, it remained on schedule. It is the only major DOD acquisition program still is within budget, and technically sound. It is the one military program with enough civilian potential to actually reduce costs. Eliminating this program would place our military people at unnecessary risk, and close the door on the American lead in a revolutionary aviation technology.

As Congressman it is critical that we account for all these facts and make a decision that is best for the whole nation -- not just DOD's five year ledgers. Once we do that, there is no question in my mind that Congress won't do the right thing and fund the V-22.

Mr. **Torricelli**. Thank you very much, Curt, and thank you both for taking the time and the effort to make a persuasive presentation. It is, of course, no coincidence that the committee has chosen this time to have this hearing. It is our own way of demonstrating that in addition to the very real military factors that you have outlined, that are appropriately considered by your own committee, the implications for the future of American leadership in aerospace are just as or more real.

My hope is that whether we succeed or fail in maintaining the military program, that your—the interest and enthusiasm you both demonstrated will continue, as this committee, or at least this member, works to ensure that this has a—this technology has a place in our civil aviation future.

We have started, largely without notice, that effort this year. This subcommittee has changed the FAA authorization to include planning for flight control to accommodate tiltrotor technology, to ensure users and developers as this plane came into existence that it would not be subjected to all of the current difficulties of air control, that it would have real competitive advantages, and to plan the infrastructure, knowing that, as well, that these aircraft would not operate off the currently congested facilities, but have convenient accessible facilities available to it when it was developed.

We started moving that planning process forward, so as we make our individual judgments whether to assist in military procurement, I trust you will join us in the civil side as well.

Finally, I wanted to say on the military side, though I do not serve on your committee, that those who doubt the need and application of the technology should simply ask the families of those who died in the Iranian desert.

The continued use of military helicopters for roles for which they were never designed and are not capable are going to incur continuing military difficulties. Helicopters are simply not manufactured to cross hundreds and hundreds of miles of difficult terrain and air space. We learned that painfully, and as you pointed out, Mr. Weldon, there are tragically going to be more such missions in the future.

That history would have been very different if the technology had been available to place those soldiers in that hostile terrain at higher speeds with greater capability.

Thank you, both, for your testimony. If we could at this point—Mr. Campbell?

Mr. **Campbell**. Thank you, Mr. Chairman.

I won't detain my colleagues. I want to thank you. It was very, very forceful and instructive. I would ask, if it hasn't already been done, on behalf of my ranking member, that Mr. Lewis' opening statement be, without objection, entered into the record.

Mr. **Torricelli**. Without objection.

[The prepared opening statement of Mr. Lewis follows:]

HON. TOM LEWIS (R-FL)
OPENING STATEMENT
CIVIL TILTROTOR HEARING
JULY 17, 1990

THANK YOU, MR. CHAIRMAN.

I AM PLEASED THAT THE SUBCOMMITTEE IS HOLDING THIS HEARING TO EXAMINE FURTHER THE CIVILIAN APPLICATIONS OF THE TILTROTOR AIRCRAFT.

THE COMMERCIAL POTENTIAL OF THE TILTROTOR IS TREMENDOUS. THE TILTROTOR AIRCRAFT CAN LAND AND TAKE OFF VERTICALLY LIKE A HELICOPTER AND THEN FLY LIKE A PLANE BY TILTING WING-MOUNTED ROTORS TO THE PROPELLER POSITION. THIS UNIQUE CAPABILITY MAKES IT A VIABLE SOLUTION TO MANY OF THE MAJOR PROBLEMS FACING THE INDUSTRY TODAY.

TO RELIEVE AIRPORT CONGESTION, VERTIPORTS CAN REPLACE AIRPORTS IN MANY CASES, THEREBY ELIMINATING THE NEED FOR THOUSANDS OF ACRES OF LAND AND BILLIONS OF DOLLARS IN CONSTRUCTION COSTS. VERTIPORTS REQUIRE, AT MOST, FIVE ACRES OF LAND AND CAN BE CONVENIENTLY LOCATED DOWNTOWN. WITH ITS SPEED OF UP TO 300 M.P.H., PASSENGERS CAN FLY THE DISTANCE FROM DOWNTOWN WASHINGTON, DC TO DOWNTOWN NEW YORK IN A MATTER OF 40 MINUTES. THIS SHORT FLIGHT IS MUSIC TO MANY A COMMUTER'S EAR.

ANOTHER POTENTIAL BENEFIT IS THE ECONOMIC BENEFIT TO BE GAINED FROM THE COMMERCIAL TILTROTOR. THE WINNER OF THE TILTROTOR MARKET CAN EXPECT A SALES FIGURE AT LEAST IN THE HUNDREDS OF MILLIONS PER YEAR. IF WE DO NOT MOVE TO STRENGTHEN THE COMMUTER AIRCRAFT SEGMENT OF THE AEROSPACE INDUSTRY, EUROPEAN COUNTRIES AND JAPAN WILL BE WAITING TO GRAB THE OPPORTUNITY.

IF THE TILTROTOR FOLLOWS THE CLASSIC ROUTE, THE CIVIL TILTROTOR APPLICATION WILL WAIT UNTIL THE MILITARY VERSION HAS BEEN PROVEN. THEREFORE, IN ORDER FOR THE UNITED STATES TO MAINTAIN THE LEAD IN TILTROTOR TECHNOLOGY, THE DEPARTMENT OF DEFENSE MUST CONTINUE DEVELOPMENT OF THE MILITARY V-22. POTENTIAL CIVIL APPLICATIONS ENORMOUSLY STRENGTHEN THE CASE FOR INCREASED FUNDING.

I LOOK FORWARD TO HEARING THE OPINIONS OF OUR WITNESSES AND THEIR PREDICTIONS AS TO THE FUTURE OF THE TILTROTOR AND ITS CIVILIAN POTENTIAL.

THANK YOU, MR. CHAIRMAN.

Mr. **Torricelli**. Mr. McMillen.

Mr. **McMillen**. Thank you, Mr. Chairman.

I am sorry that I missed your presentations, but I just had one quick question on the cost and operational effectiveness analysis and study. What is the status of that? When is it due to be released?

Mr. **Weldon**. Mr. McMillen, I have a copy of it in front of me and I'd be happy to submit one for the record. I did have it entered into the official record of the House this morning. It is available now. It's been out for about two weeks. It was due out several months ago. There are many of us who felt that perhaps it was being delayed within the hierarchy of the Pentagon, an outstanding independent analysis commissioned by the Pentagon that reinforces everything that was said over the last year in terms of comparing the alternatives.

So it is available to you. There's an executive overview that I have in front of me which I'll make available to you. Dr. Simmons is available if you would like to bring him in. He'll be before the Senate Appropriations Committee, I believe this Thursday or perhaps next week. I think when someone—when one looks at this analysis and compares the alternatives, you'll come to the same conclusion that everyone's that read it has come to, except for Secretary Cheney, and that is that the V-22 alternative is the best alternative under any scenario, even if you take the reduced buy to match the funding profile for his alternative aircraft buy.

Mr. **McMillen**. I thank the gentleman.

Mr. **Torricelli**. Thank you, Mr. McMillen.

Gentlemen, if you would like to join us for any portion of this, if your schedules allow, please feel free to do so. We'd be only too glad to have you.

Thank you very much for joining us.

Mr. **Geren**. Mr. Chairman, thank you very much for hosting this hearing.

Mr. **Torricelli**. Thank you.

For our first panel, please, if we could have Morris Flater, President, HubExpress Airlines; John Finley, Managing Director, Feeder Aircraft Operations, Federal Express Corporation; James Muldoon, Director, Aviation Technical Services, Port Authority of New York and New Jersey.

Gentlemen, thank you for joining us today. We appreciate your efforts and in advance, your testimony. We would like to receive testimony from each of you, if you could. The entire text of your testimony will be entered into the record so it can be shared with all of our colleagues. We would invite you to summarize, as you believe appropriate. We would, of course, because we have a number of panels and like to engage in as much questioning as possible, ask you to reserve the balance of this time for questioning, however.

With that in mind, if we could, Mr. Flater, I have you first on my list. If you would please proceed.

STATEMENTS OF MORRIS FLATER, PRESIDENT, HUBEXPRESS AIRLINES, STOW, MASSACHUSETTS; JOHN FINLEY, MANAGING DIRECTOR, FEEDER AIRCRAFT OPERATIONS, FEDERAL EXPRESS CORPORATION; AND JAMES MULDOON, DIRECTOR, AVIATION TECHNICAL SERVICES, PORT AUTHORITY OF NEW YORK AND NEW JERSEY

Mr. FLATER. Thank you, Mr. Chairman.

I am, of course, Morris Flater, President of HubExpress Airlines, and HubExpress is a fully certificated regional airline. It operates as a feeder to major domestic and international airlines now serving Logan International Airport in Boston, Massachusetts.

I am very pleased to have this opportunity to appear before you to discuss the civil applications of tiltrotor technology. I consider this to be of just vital importance, both to the regional airline industry and also to the many, many communities across America served by the regional airline industry.

I'd like, if I can first, to talk just briefly about our Boston market because I think it is in microcosm—it is an example of how effective the civil tiltrotor can be in an urban market. So, having said that, I think—I'd like to point out that Eastern Massachusetts, including the city of Boston and the many communities which surround that city, is probably one of the most recent major seaboard centers on the East Coast to witness a major growth in population.

The roadways, while they were ample for traffic, oh, 10 or 20 years ago, they now accommodate a volume which far exceeds their design capacity. Access to Logan International Airport is limited to a two-lane tunnel built more than 40 years ago. During the late 1940s, planners forecast Logan enplanements at about 6- to 8 million passengers per year. Today, more than 25 million passengers use Logan Airport annually, either as a point of origin or as a point of departure. Both the tunnels and these roadways that lead to the tunnels are congested just about all of the day.

Now, there are a lot of major businesses that are important to the Massachusetts economy located not right there in downtown Boston, but about 12 to 30 miles west and north of the city on a couple of major beltways, 128 and 495, for those of you who are familiar with Boston, companies like Raytheon and GTE, Hewlette-Packard, Digital Equipment, General Electric, Reebok and so forth and so on. These are vitally important to the Massachusetts community.

Access to Logan Airport for these companies and for many, many smaller companies is just critical because that airport, that regional airport, is a lifeline to their markets. With the increase in traffic congestion experienced in the past 10 years, a 30-minute drive to the airport has really become a test of stamina. It now takes up to two hours to go a simple 12 miles during rush hour.

To remedy the situation, a group of business people formed our company, HubExpress, back in 1986. The argument was made that if it takes just 57 minutes to fly from Boston Logan's Airport to New York LaGuardia, why does it take twice that amount of time just to get to the airport?

Once we were organized, we sought and we obtained landing rights at Logan Airport and then we went out around the periphery of Logan and Boston, in communities around Route 128 and 495, and we built helipads where the major hotels are and the major office parks. We explained to them that this was a great amenity for them. It would attract business market to them and it would serve their market very effectively and it has done so.

We got IATA, in Montreal, to assign three-letter international identifiers to each of these little heliports and now you could book, literally, from Heathrow Airport in London to one of our heliports in the periphery of Boston. These are now international destinations, if you will.

Our schedules and these heliport destinations are accessible today by travel managers across the world, across the country, on computer reservation systems like Saber and Apollo and PARS.

Now, according to studies produced by the Port Authority, about half of Logan's 24 million annual enplanements are originating from the suburban markets just outside the core city that we serve, and yet there is no really satisfactory means of transportation, no alternative other than ground transportation available to all of these communities. You can imagine the loss of time and the effectiveness of these people that work with these various companies in taking up to two hours or half a day to get to and from them.

Within Massachusetts, transportation executives are now talking about train technology, which is, of course, an 18th century technology. Trains are really a very expensive technology, costing up to, oh, $20 million per track mile. It's a very inflexible technology. Once the costs are sunk, the track bed and stations are pretty much in one place forever.

By comparison, the civil tiltrotor is a flexible device. As markets change, the tiltrotor simply moves to wherever the demand is greatest. For the commercial operator like my company, the investment remains intact.

The reason I elaborate so much on Boston is because there are many other communities across our country which face similar problems. This gridlock phenomenon is duplicated, I think, in many, many other cities.

One—we have one such alternative today which is the civil tiltrotor. That alternative is now within our grasp and I would say that all we need is the equipment and we need the commitment.

Under Federal 90/10 programs, our government spends billions every year on airport and runway expansion, in fact, over 17 million this next year. Imagine the savings in existing Federal Government outlays if we adopted the civil tiltrotor as a public policy goal.

The solution, I think, is really commercial tiltrotor service. If this aircraft were commercially available, I think that service could be instituted today. We could increase the capacity of our existing airports by 30 percent or more without spending another dollar of our scarce revenues. I believe the answer to our airport congestion lies with the tiltrotor technology and not more airports.

If commercial tiltrotor service could be instituted today, I also predict that the greatest benefit would accrue to small and medium-sized communities across America which currently have no scheduled service. From my perspective as a regional airline executive, I can easily envision commercial tiltrotor services springing up within a few short years in markets like Boston, New York, Newark, Philadelphia, Phoenix, San Francisco and so on. Communities within 150-mile radius of these cities would only be 30 minutes or less away via tiltrotor from connecting service to markets across the world.

In summary, from a public policy perspective, there are two major transportation problems that we're now facing in the 1990s. One is a urban transportation problem. Cities are just too crowded. Roadways far exceed their planned capacity. Second, airport congestion. There are not enough slots. There are enough runways and I would submit to you that the answer is a civil tiltrotor. I think that the development of the civil tiltrotor should be a national public policy goal.

I think, in closing, I wish to point out that I've been associated with helicopters in one fashion or another for about 25 years, as a marine aviator, I flew helicopters during the 1968 Tet offensive in Vietnam. I have the dubious honor of being shot down in a Boeing CH-46 helicopter about eight miles west of Danang in 1968, and being picked up by a Bell Huey gunship, but I can certainly testify from my personal experience that the civil tiltrotor is the most innovative rotorcraft technology to be devised during my lifetime. It's commercial applications are just enormous.

As a commercial operator, I would like to see the V-22 Osprey adopted as a military program first so that when it becomes available commercially, the engines and the transmissions and the rotors and the major components will have the sort of TBOs, the component lifetimes that we in the commercial airline industry require for this device to be commercially effected, because only with the extensive military experience with the FAA extend component overhaul and maintenance intervals into the ranges we require.

Suppose for one minute, suppose that the Federal Government elects not to pursue this as a DOD pursuit. In that situation, the only alternative that I personally see right now to put this kind of technology into commercial hands is a program whereby there is a guarantee of procurement costs for a commercial airline because most of us—we don't own—we can't go out and buy these aircraft right off of our balance sheets. We have to go to London or to New York to leasing companies. They're going to say, "Gee, this is an experimental technology; it's not yet proven." Not yet proven. And as a result of that, we need, in effect, a government guarantee, if you will, of the paper that is used, the purchase money paper.

I submit to you that's not a very happy experience for anyone in government these days to pursue. Secondly, however, I would also like to point out that a commercial operator like HubExpress would incur enormous operating cost. Imagine trying to operate a commercial airline with 100 hour, 500 hour, 1000 hour TBOs on your engines and rotors and so forth. We'd have to have five or six aircraft in lieu of just one to do these jobs.

So what I'd like to point out to you is we want that aircraft when you can give it to us with a 4000- to 6000-hour TBO. That's when we want it. Otherwise, we're going to take horrendous subsidies that I know you don't want to pay and if you do, I know where you can find the money, but I don't want to get into that right now. I think that it's there.

Without question, regional airlines like HubExpress across the world will purchase the civil tiltrotor once it becomes commercially available. The only question remaining in my mind is are we going to pay for it with dollars or foreign currency?

In closing, there are two prophets of New England aviation who cannot be here today, but they wanted their voices to be heard. One is George A. Keen, our Chairman of the Board at HubExpress Airlines, and the other is Mr. Barry Birmingham, the Chief of the New England Regional FAA Vertiport Development Office. Both asked to have their names as endorsers of the technology.

Thank you, Mr. Chairman. I appreciate the opportunity to speak with you today.

[The prepared statement of Mr. Flater follows:]

TESTIMONY
BEFORE THE
HOUSE SUBCOMMITTEE ON SCIENCE
HEARING ON
CIVIL APPLICATIONS
OF
TILTROTOR TECHNOLOGY

JULY 17, 1990

MORRIS E. ("RHETT") FLATER
PRESIDENT

HUBEXPRESS AIRLINES
MINUTE MAN AIR FIELD
STOW, MASSACHUSETTS 01775

TEL. 508-897-7053
FAX. 508-897-7645

CIVIL APPLICATIONS OF TILTROTOR TECHNOLOGY

Mr. Chairman, I am Morris Flater, president of HubExpress Airlines. HubExpress is a fully-certificated regional airline operating as a feeder to major domestic and international airlines now serving Logan International Airport in Boston, Massachusetts.

I am very pleased to have this opportunity to appear before the Aviation Subcommittee to discuss the civil applications of tiltrotor technology which I consider to be of vital importance both to the regional airline industry and to the many communities in America served by that industry.

THE BOSTON MARKET - A CASE STUDY

First, I would like to discuss briefly the background of HubExpress Airline in Boston, and the environmental conditions which brought it into existence. By doing so, I believe it will be evident why within the next decade it is essential that equipment like the civil tiltrotor be placed in service throughout domestic markets.

Eastern Massachusetts, including the city of Boston and the many communities which surround the city, is the most recent of the major seaboard centers on the east coast to witness a major growth in population.

The roadways, while ample for traffic some ten or twenty years ago, now accommodate a volume which far exceeds their designed capacity. Access to Logan International Airport is limited to a two-lane tunnel built more than 40 years ago. During the late 1940's, planners forecast Logan enplanements at 6 million to 8 million passengers annually. Today, more than 25 million passengers use Logan Airport annually either as a point of origin or destination. Both the tunnels and the roadways leading to the tunnels are congested throughout most of the day.

Many major businesses which are important to the Massachusetts economy are located not in Boston proper but 12 to 30 miles west and north of the city on two major beltways - Route 128 and Interstate 495. Among these are Raytheon, GTE, Hewlette-Packard, Digital Equipment, General Electric, Reebok, NEC, Mitre, M/A Com, Analog Devices, Stratus Computer, Wang Laboratories, Prime Computer, and Phoenix Technologies.

For these and many smaller companies, access to Logan Airport is critical since the airport is a lifeline to their markets. Yet with the increase in traffic congestion experienced in the past 10 years, a 30 minute drive to the airport has become test of stamina, requiring a drive of up to two hours. According to many corporate travel managers in the Boston area, employees and customers now budget nearly a half-day to get to and from the airport. You may imagine the productivity loss brought by these delays.

To remedy this situation, a group of business people founded HubExpress in 1986 as a response to transportation problems affecting eastern Massachusetts. They figured that if it takes only

57 minutes to fly to New York on what was then the Eastern Shuttle, the drive to Logan airport should not require twice that time.

Once organized, HubExpress sought and obtained landing rights at Logan's main terminal area and a ring of office parks, business locations and hotels on the periphery of Boston where business people congregate. With its hourly schedules, HubExpress helicopters have reduced commuting time to the airport to 10 to 15 minutes. With IATA three-letter identifiers, its heliports are international destinations. HubExpress's schedules and its heliport destinations are accessible to travel agents using computer reservations systems across the world.

LOCAL MASSACHUSETTS TRANSPORTATION ALTERNATIVES

According to studies produced by the Massachusetts Port Authority, about half of Logan's 24 million passenger enplanements either originate or are destined to the suburban markets served by HubExpress. There is no satisfactory mass transportation alternative available to these communities, even though goods and services produced in these communities are critical to the health of the Massachusetts economy.

Transportation executives within the state government are considering trains as a possible solution. But trains are an expensive technology - it costs about $20 million per mile for new track; trains are unpopular - no one who has ever fought an eminent domain contest has emerged unscathed, politically or economically; and trains are inflexible. Once the costs are sunk, the trackbed and stations are there in one place forever. By comparison, the civil tiltrotor is flexible. As markets change, the tiltrotor simply moves to wherever the demand is greatest. The investment remains intact.

THE CIVIL TILTROTOR - A NEW TRANSPORTATION SYSTEM

The reason I elaborate so much on Boston is because many other communities face similar problems. The urban gridlock phenomenon is not unique to Boston.

Communities across the country, like Boston, badly need alternatives to ground transportation to access major airports.

One such alternative - the civil tiltrotor - is now within our grasp. All we need is the equipment and the commitment.

The single greatest advantage offered by tiltrotor technology is the fact that, like the helicopter, the aircraft does not require an airport, nor does it take up valuable landing slots at existing airports. The tiltrotor can land on a airport taxiway or in an area the size of a small parking lot.

Under federal 90/10 programs, our government spends billions every year on airport and runway expansion and highway improvements. Imagine the savings in existing federal government outlays if we adopted the civil tiltrotor as a public policy goal.

Let me elaborate. Many of our major airports are operated at maximum capacity. About 41% of all flights involve distances of 300 miles or less - within easy range for a civil tiltrotor. The FAA has released a 1989 study showing that 16 airports are already congested - literally at capacity. Within 10 years, passenger travel will double. I doubt that there will be a major airport in the land that is not at or above capacity.

The solution, I submit, is commercial tiltrotor service. If the aircraft were available, the service could be instituted today; we could increase the capacity of our existing airports by 30% or more without spending another dollar of our scarce tax revenues. The answer to much of our airport congestion lies with the tiltrotor technology, not more airports.

If commercial tiltrotor service could be instituted today, I predict that the greatest benefit would accrue to small and middle-sized communities across America which currently have no scheduled service.

From my perspective as a regional airline executive, I can easily envision commercial tiltrotor services springing up within a few short years in markets like Boston, New York, Newark, Philadelphia, Phoenix, San Francisco, St. Louis, Dallas-Fort Worth, Los Angeles, Miami, Atlanta, Denver and Chicago. Communities within a 150 mile radius of these cities will be only 30 minutes away via tiltrotor from connecting service to markets throughout the world. With hourly service during peak travel times, and airline joint fares to reduce the costs of tiltrotor travel to the consumer, commercial tiltrotor services should be an instant success enabling businesses in rural communites to gain access to wider markets.

You should know other countries like Japan and several European nations have announced plans to build similar versions of the civil tiltrotor. Although Bell and Boeing developed the technology here in the United States, transportation planners abroad are already devising transportation systems using similar technology. So our time is short if U.S. manufacturers are to maintain their lead.

In closing, I wish to point out that I have been associated with helicopters, in one fashion or another, for almost 25 years. As a Marine aviator, I flew helicopters during the 1968 Tet offensive from Marble Mountain and other bases in I Corps and from aircraft carriers in the South China Sea. The civil tiltrotor is the most innovative rotorcraft technology to be devised during my lifetime. Its commercial applications are enormous.

I would like to see the V-22 Osprey adopted as a military program, so that when it becomes available commercially the engines, rotors, transmissions and major components will have the 6,000 hour TBOs we need in commercial aviation to make the aircraft cost effective. Only with extensive military experience will the FAA extend component overhaul and maintenance invervals into ranges we require.

Without question, regional airlines like HubExpress across the world will purchase the civil tiltrotor once it becomes commercially available. The only question remaining in my mind is whether we will be purchasing the aircraft with dollars or foreign currency.

This concludes my testimony. I would be pleased to answer any questions you may have.

Mr. **Torricelli.** Thank you for being with us.

Mr. Finley.

Mr. **Finley.** Mr. Chairman, thank you. Federal Express has one object in life and that is to compress time. I am going to compress yours and this airplane can compress our service for our customers.

I also, as your colleagues pointed out, I worked for General Smith also, who is extremely interested in this airplane and it marches to every drummer that he ever used in technology or concept in changing the world—the way the world does business, i.e. just-in-time. That is said with the concept that the use of this aircraft has to be extremely innovative.

Additionally, I don't want to say that the aircraft is totally a beautiful baby. There are some warts which I would like to point out, and they are particularly apropos, as my colleague, Mr. Flater, said, and as you earlier let on, without the military learning curve, there is a real question that anybody in the commercial industry can stand to go it alone.

We have to have absolute reliability. That's all we sell our customers. And the aircraft appears to start out in our use on a onesy-twosey route structure and, therefore, it's got to stand alone. We cannot afford to buy a lot of spares at the exorbitant price without the military experience in front of it.

We are willing, however, to evaluate the airplane, not on its—not just by itself, but we'll look at it as system synergy. It might not make a lot of sense by itself, but on the cream or the milk of the entire Federal Express fleet, it might make some sense as an innovative method for our customers, marketing, all that sort of thing. So we're not ruling out that the airplane, because it itself does not make money, does not make money for Federal Express, and we're willing to look at it that way.

But in evaluating in that concept, we don't have enough information as to the DOCs of the airplane, what the MTBOs are going to be, all those things you learn through a military learning curve.

Some other thoughts, just very quickly, is that unfortunately, it appears that the airplane, to us—I am not developing my Federal Express paranoia—is going down the passenger curve first. That increases the cost to the airplane and dilutes the interest to us because we would design the aircraft somewhat differently than the PAX would. I understand where the money is and we've learned to live with it, but it is a thought.

Again, the heretical word I echo, subsidy. If we don't get the military learning curve, the military numbers of aircraft to draw down the cost of the airplane, something else has got to be looked at because I don't know anybody that can pony up to this airplane on a cost-per-mile basis if it starts out in the civil world.

We are extremely interested—as I said before, it marches to every drummer that Mr. Smith ever used and we want to support the program. We do have those reservations.

That's all I have, sir.

[The prepared statement of Mr. Finley follows:]

FEDERAL EXPRESS CORPORATION

TESTIMONY ON A COMMERCIAL / CARGO TILTROTOR AIRCRAFT

SUBMITTED FOR THE RECORD
TO THE

U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE,
AND TECHNOLOGY

JOHN L. FINLEY
MANAGING DIRECTOR
FEDERAL EXPRESS CORPORATION
28 JUNE 90

FEDEX TILTROTOR SUMMARY

- A "TIME MACHINE" OF CONSIDERABLE IMPROVED SERVICE POSSIBILITIES TO FEDEX
  - JIT (JUST IN TIME)
  - CITY TO CITY (LANDING PORTS; ATC SYSTEM)
  - INNOVATIVE!

- ADVANCED TECHNOLOGY (FEDEX KEYSTONE)
  - DOUBLE EDGED SWORD
  - NO MILITARY LEARNING CURVE

- ABSOLUTE RELIABILITY
  - SINGLE AIRCRAFT / BACK UP
  - LANDING MINIMA (CAT II/III)
  - ICING

- COST EFFECTIVE
  - EXTREMELY EXPENSIVE
  - EVALUATE ON SYSTEM SYNERGY - NOT JUST ON THE AIRCRAFT ALONE
  - DOES NOT APPEAR THAT ANY SINGLE OPERATOR CAN "BLAZE THIS TRAIL" ALONE

- AD HOC THOUGHTS
  - NO REAL STUDY TO DETERMINE NON RECURRING COSTS / DOC'S
  - DESIGNED FOR / PROCEEDING DOWN THE "PAX ROAD" – AGAIN
  - TEST PROGRAM

- SUBSIDY

- FEDEX INTEREST / SUPPORT

TILTROTOR

Federal Express, while there are obviously other rationale for its aircraft selection success, utilizes, among many, four very significant criteria when evaluating an aircraft such as the V-22 Osprey. Those are:

1. Impact on timely pick up and delivery of packages, or as it has become known in the market place, Just In Time -- JIT.

2. Strong use/reliance on technology advancement developed "in house" or by others.

3. Absolute reliability.

4. Cost effectiveness, or the ability to return an acceptable profit on our investments.

Utilizing those four rather basic criteria, I would like to address them as we at Federal Express think they apply to the evaluation of the V-22 in the commercial express cargo business.

1. JUST IN TIME PICK UP AND DELIVERY

As some of you may have noticed, I have expanded the common use of JIT to include the pick up phase. Most of you are familiar with or hear JIT only as it is applied to the delivery phase. The pick up phase of our operation utilizing the V-22, could be expanded in some areas to "just in the nick of, or latest time" if the use of the aircraft is innovative. I stress innovative. The aircraft, quite possibly, gives us the ability in such places as Manhattan (City Center) to extend our pick up times considerably, i.e. one to two hours, and still make a sort in IND, MEM or deliver packages straight to City Centers in Boston, Chicago, Washington D.C., etc.

The key when addressing the JIT philosophy is that the aircraft appears not to make sense in either its pure helicopter or pure fixed wing mode when "mated" to a nearby trunk aircraft. We can and now do that, i. e. feed the trunk with helo's, C-208's and F-27's, very reliably and relatively cheaply. The Osprey must be utilized in an extremely innovative fashion which allows it to become a true time machine utilizing the best mix of its vertical, STOL and horizontal capabilities.

As an example, that usage might be vertical at one end, utilizing its fixed wing capabilities over longer ranges to a fixed wing/STOL landing -- or vice versa. But, not airport to airport. The aircraft appears to have its most value engineered mode in city center to city center.

The V-22 opens new horizons and a clean sheet of paper must be utilized to properly examine cost effective, conceptual uses. The aircraft must not be thought of as just an adjunct to a trunk system or as a "standard" part of a hub and spoke network. Therefore, in the JUST IN TIME mode, the thinkers in our industry, manufacturing and government must find a new concept for use of the airplane which innovatively expands pick up and delivery windows, and develops new route concepts. This obviously, probably calls for large systemic changes, i.e. Vertiports, ATC, etc. That is quite different from the past experiences of the requirements with advancing technology in the aviation industry.

2. TECHNOLOGY ADVANCEMENT

Federal Express has been a cornerstone both in the development and the advancement of technologies for use in our industry. The ability in real time to track, scan, and follow packages from "cradle to grave," CAT II/III on older aircraft and the development of jet engine hush kits, etc. are just a few examples of the things that mark our recognition of and dedication to the use of technology as a competitive base against our "foes."

The V-22 offers an exciting possible advantage in technology. We have for some time, because of that, been following, been very interested in, and very supportive of the aircraft. Our previous discussions with industry and government agencies have forecast great possibilities and concepts for accomplishing increased service to our customers. But, with advanced technology and particularly technology as generally sophisticated as that involved in this aircraft, there is a very substantial associated downside risk -- notably in the initial implementation and "learning curve" phase used to work out the operational bugs with no real operational data to fall back on or, unfortunately in this case, possibly no previous military usage. We have to essentially "go it alone" and blaze our own new trails with new technology.

One of the premier value added aspects of the program was its military usage that, to a large degree, would have allowed a lot of the operational/fleet bugs to be expunged at the cost and time of the government. It, therefore, provided a much cleaner transition to use in the commercial world. There is a very real question that the implementation/learning curve costs, or time, for that matter, can be absorbed in a competitive commercial environment where a very large amount of "learning/correcting" dollars will now still probably have to be spent up front -- and it appears at least at this juncture by a very few trail blazers.

In this regard, some sort of test program on a small scale is obviously called for and we have discussed it with the appropriate industry and government personnel. But from our standpoint, if FEC were to participate in something of that nature, it would have to be on a basis where our customers were not put at risk -- and it has to prove innovative concepts -- not just that the airplane can fly A - B.

I am absolutely sure that when the Kitty Hawk Flyer first flew, there were many who questioned the real value to such technological advancement, or saw any business future for the "machine." We at Federal, do not espouse technology for technology's sake. But, technology that offers us the opportunity to improve our reliability and customer service is not and will not be dismissed. The V-22 technology offers our industry a very real service improvement possibility, but it is not risk free.

3. ABSOLUTE RELIABILITY

All of you want your packages at 1030 and you're not particularly interested in our problems in getting them to you. Or, if you want them picked up at 5 o'clock or later, that is exactly what you want. You don't want us to be there at 4 o'clock because our primary aircraft/vehicle is down and we've had to go to a backup. You are paying for, and expect to get, absolute service reliability.

While you don't hear it much anymore, "ABSOLUTELY, POSITIVELY" is still a cornerstone of our thinking at Federal Express. Therefore, the reliability of our lift must reflect that dedication to our customer. We spend inordinate amounts of time, effort and money to make our fleet more reliable than any other fleet in the industry or for that matter, any carrier, be it cargo or passenger, in the world. Our sole product to you is unwaivering reliability of service. If we don't provide it, you darn sure ought to look elsewhere. The V-22 offers the ability to expand and improve service and compress time. But, it is an extremely complicated machine and its final (much less its initial) mechanical dispatch reliability is very uncertain, particularly without the military "pathfinders." This goes somewhat "hand and glove" with the advancement in technology rationale previously discussed.

The aircraft appears, based upon rudimentary evaluation by FEC, to have its probable initial utilization based on a onesy, twosy unique routing structure and not in any standard hub or trunk aircraft "mated" methodology as previously stated. A "center city" hub network most certainly would evolve in such places as the eastern and western corridors. But, that is a ways off. Therefore, the capability to support, spare and maintain the airplane also requires very innovative thinking. In simple words you probably cannot generally afford to have a dedicated spare aircraft, particularly of this cost and complexity for one or two routes. The basic primary aircraft has to stand on its own. Consequently, the reliability of the aircraft must be extremely high. And truly unique means of recovering/backing it up must be found, because it unfortunately still will "squat." In short, there is a question that the established single aircraft mechanical dispatch reliability, desired by our commitment to service, can be met by the V-22.

While the mechanical dispatch reliability is of prime importance, the aircraft must also be operationally reliable, i.e. able to operate under marginal weather conditions, most notably instrument (CAT II/III)/icing conditions. If it has no or limited all weather capability (and I have been told, as an example, that in the vertical mode, it may not be certified in known icing), its interest to us is reduced. It would initially appear that to make innovative use of the aircraft, we would be utilizing it in areas of operation (Example: New York City Center) where we would be placing considerable "golden" packages at risk with marginal or no capability to recover them should the airplane be unable to launch for weather or to die in the chocks for mechanical reasons.

While it didn't seem to fit anywhere, I have to say something about design: designing/thinking PAX . . . You are once again thinking and designing for PAX. While I certainly understand why -- when you do that, you dilute the package capability and quantumly increase the cost, and once again, reduce our interest.

4. And lastly, THE COST EFFECTIVENESS OF THE AIRCRAFT

Federal Express is in business to serve you with the most reliable, timely product of its kind in the world. But, to do that, we have to stay in business and, therefore, our aircraft acquisitions and the use of same must be cost effective to the system in general, i.e., sometimes not on a stand alone basis, but possibly based on overall system synergy both from the aircraft fleet and customer standpoint. There are several examples to support the "system synergy" concept, which can be provided if required.

Quite frankly, the anticipated price of this aircraft vs. its load carrying capability does not give it a lot of real up front allure. Follow on true commercial variants may alter that. But at this time, that is uncertain. Therefore, it becomes obvious that the airplane must be considered as a pure time machine with a definitive use that will enhance our customer base, provide a marketing/public relations bonanza, or give public recognition to the dedication by this company to technology that affords "value added" for the customer.

We, as I said, are quite willing to analyze the aircraft on a systemic basis and not on a stand alone basis. It may not make sense on a specific route, but piggybacked on the entire system, coupled with marketing/public relation's "positives," might be worth the added cost. But, at this point, that is very uncertain.

We must once again be assured that we are getting the most innovative use out of the aircraft and the subjective additive rationale and benefits flowing from the airplane will let it be the cream floating on the supporting base of the milk of our entire fleet and lift system. And while it may be heretical to use the word -- subsidy -- at least through a full test program, subsidies should most certainly be evaluated.

As I stated initially, Federal Express continues to be interested in the airplane. It "marches" to all of the concepts that Mr. Smith has employed in literally revamping the world's way of doing business.

Federal Express is the premier member of the express cargo industry and well intends to remain so. And, we will always thoroughly evaluate concepts and technology such as this aircraft represents. We most definitely wish to stay abreast and be an integral part of the program, to evaluate the aircraft's use, and to aid any government or other agency in evaluating its effectiveness in the commercial express cargo market.

But, we do have to see the "daylight" -- and I hope it's there -- before any formal commitment could be made. Only by utilizing the total strengths of groups/individuals in conferences and open forums such as this, do we have a hope of getting there.

Thank you for letting FEC participate today.

1815N

Mr. TORRICELLI. Thank you, Mr. Finley, very much.

Mr. Muldoon.

Mr. MULDOON. Thank you, Mr. Chairman.

My name is Jim Muldoon; I am General Manager of Technical Services for the Port Authority of New York and New Jersey, and I appreciate the opportunity to come here and talk to the committee on the important issue of the tiltrotor.

The Port Authority of New York and New Jersey envisions the development of the civil tiltrotor passenger transport with potential to revolutionize our capacity-starved air transportation system. In 1989, the Port Authority airports accommodated almost 75 million passengers and just over a million aircraft movements, figures that actually dipped somewhat below 1988 levels.

What is disconcerting is the delays grew at LaGuardia by 113 percent, at Kennedy, by 52 percent, and at Newark, by 17 percent over 1988 levels, despite the flattened volume of traffic.

This situation is not likely to improve over the next 10 years as the number of aircraft movements is projected to increase by 13 percent and by passengers by nearly 50 percent.

We recognize that the lack of available real estate in our region, coupled with serious environmental concerns, virtually precludes building a new airport or new runways at our existing airports. As a result, we find ourselves increasingly dependent upon applications of advanced communication, navigation and surveillance technologies to provide incremental capacity gains.

At some point, however, fine-tuning will no longer be enough. Without new airports, a breakthrough technology is needed, operating independent of established airports and airways. The civil tiltrotor, combining helicopter point-to-point service with turboprop speed and comfort, can provide a quantum leap in system capacity.

It is significant to note that the three Port Authority airports, 44 percent of the departures deliver only 18 percent of the passengers to destinations within 300 nautical miles, a distance well within the range of the tiltrotor aircraft. Displacing even a fraction of this short-haul traffic would dramatically reduce delays at our capacity-constrained airports, which last year accounted for roughly one-third of the estimated $5 billion cost of delay in the United States.

Encouraged by these implications, we at the Port Authority have invested considerable resources in exploring the potential of the civil tiltrotor. In 1987, we commissioned a study that confirmed the feasibility of city-center/city-center service. Our consultant identified a regional market of some 5- to 8 million tiltrotor passengers in the year 2000. We are currently sponsoring two additional studies. The first is an investigation of the feasibility of tiltrotor commuter-type operations to off-duty runways or to on-airport vertistops. Commuter aircraft currently represent 19 percent of the total traffic during the peak hours at our airports, but accommodate only 3 percent of the passengers, clearly, an inefficient use of increasingly scarce runway capacity. This study should be completed by the end of the summer.

The second, aimed at identifying vertiport sites along the Manhattan waterfront, is scheduled for completion by the end of the year. Our pursuit of this advanced technology is entirely consistent with Secretary Skinner's recently released National Transportation

Policy. In that document, the tiltrotor is identified as the vehicle of choice to fill the 100- to 500-mile market niche. The policy calls for further analysis to assess the feasibility and relative cost benefits, et cetera.

I believe that the Port Authority and other agencies conducting tiltrotor studies across the country are on the right track. However, I believe that a stronger commitment is needed from the Federal Government since we are dealing with a national problem that impacts the national economy and all of its citizens.

There are, unfortunately, many obstacles to be overcome in the creation of an effective VTOL transportation system, not the least of which is the lack of leadership within the civil aviation community. The recent redesignation of FAA's Tiltrotor Program Office as a Vertical Flight Program Office is consistent with what appears to be the administration's new philosophy of letting the tiltrotor happen, rather than making it happen, a position which regrettably sends a cloudy signal to the rest of the industry.

Without steadfast leadership from the Federal Government, the civil tiltrotor is not likely to endure the inevitable short-sighted cost/benefit scrutinizing. The civil tiltrotor needs a champion. That role, in our view, belongs to the FAA. The civil tiltrotor must not be viewed by FAA as simply another new aircraft program, but rather as a capacity enhancement, much like new airports, new runways and new navigational aid systems.

Government must take the lead in security both passenger and airline acceptance of the new technology aircraft. For the tiltrotor operator to recover costs, passengers must be willing to pay a premium for time saving through portal-to-portal service. Significant savings can only be provided by a dedicated air traffic control system designed by FAA in both the enroute and terminal environment to ensure segregation of tiltrotors from the main flow of traffic.

We would like also to see greater effort directed to establishing stabilized steep approach and departure paths using electronic guidance. The reality is that the steeper the approach and departure, the better the chance that the civil tiltrotor can be woven into terminal air space with minimum noise impact.

Finally, while not of primary importance to the military, minimizing external aircraft noise is vital to the tiltrotor's success as a civil transport. Noise reduction must be integrated into every phase of the civil tiltrotor development. It is apparent that much more work needs to be done, including a strong Federal commitment to the technology that is absolutely essential to the future civil application.

Thank you.

[The prepared statement of Mr. Muldoon follows:]

TESTIMONY
BY
JAMES P. MULDOON
GENERAL MANAGER
OF
AVIATION TECHNICAL SERVICES DIVISION
THE PORT AUTHORITY OF NEW YORK AND NEW JERSEY
BEFORE THE
SUBCOMMITTEE ON TRANSPORTATION, AVIATION AND MATERIALS
OF THE
U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY

JULY 17, 1990

The Port Authority of New York and New Jersey envisions the development of civil VTOL (vertical takeoff/landing) passenger transport with the potential to revolutionize our capacity-starved air transportation system.

In 1989, the Port Authority airports accommodated almost 75 million passengers and just over a million aircraft movements, figures that actually dipped below 1988 levels. What is most disconcerting, however, is that delays grew at LaGuardia by 113 percent, John F. Kennedy by 52 percent and Newark by 17 percent over 1988 levels, despite the flattened traffic. The situation is not likely to improve as the number of aircraft movements is projected to increase by 13 percent and passengers by nearly 50 percent over the next ten years.

We recognize that the lack of available real estate in our region, coupled with serious environmental concerns, virtually prohibits us from building either a new airport or new runways at existing airports. Consequently, we find ourselves increasingly dependent upon applications of advanced communication, navigation and surveillance technologies to provide incremental capacity gains. At some point however, all the fine tuning will no longer be enough. Without new airports, a breakthrough technology is needed. Operating independently of established airports and airways, the Civil Tiltrotor (CTR), combining helicopter point-to-point service with turboprop speed and comfort, can provide a quantum leap in system capacity.

It is significant to note that at the three Port Authority airports combined, 44 percent of the departures deliver 18 percent of the passengers to destinations or first stops within 300 nautical miles, a distance well within the range of tiltrotor aircraft. Displacing even a fraction of this short haul traffic would dramatically reduce delays at our capacity constrained airports, which last year accounted for roughly one third of the estimated $5 billion cost of delays nationwide.

Encouraged by the implication, we at the Port Authority have invested considerable resources in exploring the potential of the civil tiltrotor. In 1987, we launched a study that affirmed the feasibility of city center-to-city center service. Our consultant identified a regional market of 5 to 8 million passengers in the year 2000. We are also currently sponsoring two separate studies. The first is to investigate the feasibility of tiltrotor, commuter-type operations to off-duty runways or to on-airport vertistops. Commuter aircraft currently represent 19 percent of the total traffic but accommodate only 3 percent of the passengers, clearly an inefficient use of scarce runway capacity. This study should be completed by the end of the summer. The second, aimed at identifying vertiport sites on the Manhattan waterfront, is scheduled for completion by the end of this year.

Our pursuit of this advanced technology is, by the way, entirely consistent with Secretary Skinner's recently released National Transportation Policy. In that document, the tiltrotor is specifically identified as a candidate vehicle to fill the 100 to 500 mile market niche. The policy also calls for "further analysis...to assess the feasibility and relative costs and benefits...." I believe that my organization and other agencies conducting tiltrotor studies across the country are on the right track in keeping with national policy. However, I believe that a stronger commitment is needed from the federal government, since we are dealing with a national air transportation system that impacts the nation's economy and all its citizens.

There are, unfortunately, many obstacles to be overcome en route to an effective VTOL air transportation system, not the least of which is a lack of leadership within the civil aviation community. The recent redesignation of FAA's Civil Tiltrotor Program Office as the Vertical Flight Program Office is consistent with what appears to be the Administration's new philosophy of "letting the tiltrotor happen instead of making it happen"--a position which regrettably sends a cloudy signal to the rest of the industry. Without steadfast leadership from the federal government, the CTR is not likely to endure the inevitable, short-sighted, cost/benefit scrutinizing. The CTR needs a champion. That role, in our view, belongs to FAA.

The CTR must not be viewed by FAA as simply another new aircraft program, but rather as a capacity enhancement, much like new airports or runways. Government must take the lead in securing both passenger and airline acceptance of the new technology aircraft. For the tiltrotor operator to recover costs, passengers must be willing to pay a premium for time savings incurred through portal-to-portal service. Significant savings can only be provided by a dedicated ATC system, designed by FAA in both the en route and terminal phases, to ensure segregation of tiltrotors from the main flow of traffic.

We would also like to see greater effort toward establishing stabilized, steep approach/departure paths using electronic guidance. The bottom line is that the steeper the approach, the better the chance that the CTR can be woven into terminal airspace with minimal noise impact. Finally, while not of primary importance in the military, minimizing external aircraft noise is vital to the tiltrotor's success as a civil transport. Noise reduction must be integrated into every phase of civil tiltrotor development.

It is apparent that much more work needs to be done, including a strong federal commitment to the technology that is absolutely essential to its future civilian application.

Mr. TORRICELLI. Thank you, Mr. Muldoon. Thank you, gentlemen. You've each confirmed my judgment that tiltrotor technology is the only technological breakthrough that is likely in the near term that addresses our mounting problems of noise, congestion, and the need to increase capacity all at the same time.

I'd like, if I could, Mr. Flater, Mr. Finley, to begin with each of you. Tell me specifically—you have to some extent in your testimony—what evidence you require in reaching a commercial judgment, that is, the level of operational experience, the level of cost calculation. Tell me the basic kind of elements you would like to see before you are able to either finance, which I thought was an interesting aspect to this I hadn't thought of—give me a little bit of a—

Mr. FLATER. Let me say that at the outset, this aircraft has demonstrated the capability to do the kind of job that feeder airlines in this country need to be doing today, and that is feeding the major airports because what's really going on today is there is increasing cost-savings, increasing efficiency being sought by the major, major airlines. So they're going to go to larger and larger aircraft. Their dependence on feed is becoming greater and greater, hence, they're setting up coach-sharing arrangements and joint fare arrangements.

Hence, there needs to be a device, something like the tiltrotor, that can carry people from a radius of 300 miles in to major airports and get them there in less than an hour.

Obviously—and that device needs to be able to get them there and, obviously, it cannot require expanded runways to do this and that's why the tiltrotor, I think, is going to be the answer for industries like us.

Our requirements are pretty simple, but the requirements of the financial industry—

Mr. TORRICELLI. Those are your requirements, because—

Mr. FLATER. —are exactly our requirements—

Mr. TORRICELLI. You have the same requirements because you can't use it if you can't buy it. So tell me what are the specific elements of evidence that you would need to make a commitment.

Mr. FLATER. What they're looking for, basically, is a several-year operating history. They want to know the machine can fly without breaking. They want to know that it's a reliable aircraft that is no longer an experimental aircraft. They want to know that these proponents have a reasonable lifetime because it is not—if it's not economically feasible for my airline, we aren't going to be able to pay off the purchase money indebtedness to purchase this aircraft.

So they want to know it's going to work for us and we're looking for, and they are looking for, TBOs, overhaul lifetimes, if you will, of 3600 hours, 5000 hours, 6000 hours, something in those ranges, depending on which particular component we're talking about.

That is absolutely critical—critical to them, and the only way that I think we're going to be able to get that in a relatively short term is to have this aircraft come through the military program first because that's where this machine is going to get used aggressively and a great deal. The military will put hundreds of thousands of hours in this machine in a relatively short time. That have the budgets to—

Mr. **Torricelli**. The fact that one is developed in the military and then the civilian version, pressurized version, which may have the same basic air frame, but nevertheless, has been redesigned for civilian purposes, that does not cause the financial institutions or you principal difficulties in that you're not necessarily dealing with the exact same vehicle?

Mr. **Flater**. If anything, the version that would be used by the civil airline industry in this country would be grossly simpler than the military version. We don't require rotors or blades that fold, of course. We don't require the anti-missile protections built into the skin and the framework of this aircraft. We don't require all of these things, so if anything, if it meets the military requisites, it will far exceed those required in the civilian industry.

Mr. **Torricelli**. We may need all those for the New York version.

[Laughter.]

Mr. **Torricelli**. You don't need them in Boston—

Mr. **Flater**. And there are probably some parts of Boston that you'd need it, too.

Mr. **Torricelli**. Mr. Finley.

Mr. **Finley**. Bottom-line answer to your question, assuming that this industry and this world can make the airplane reliable enough to suit people, I need to know the cost of 20 airplanes, the cost of 50 airplanes. I need to know the absolute DLCs and then we'll figure out direct operating costs of the airplane. Then we'll figure out what our customers can bear or what the system will bear, based upon 300 of the—

Mr. **Torricelli**. Each of you, in your different businesses today, what—what does the market bear in a per-mile—if that is how you calculate it—cost? As you are using your aircraft, Mr. Finely, and as you are using your current helicopters, what is your rule of thumb of what the market will bear?

Mr. **Finley**. I assume there's nobody from Big Brown sitting in here. It's a pretty close-held secret.

Let's just say that if it gets below—the way we figure it, if it gets below 40 cents per available ton mile, a big airplane makes sense to us. We have little airplanes that are approaching a dollar a ton mile, so that's why I say we're not looking at the airplane by itself where a commuter airline has to look at it primarily by itself unless it's tied to a biggie.

We are tied—we are a biggie, and therefore, we look at the whole system, but it ranges from a dollar per available ton mile down to below 40 cents an available ton mile.

Mr. **Torricelli**. Mr. Flater, how do you calculate this?

Mr. **Flater**. Let me put this into a slightly different perspective. We're looking for a machine that will cost about $250,000 per seat. That's what we're looking for. So you can multiply out the number of seats and see what we want. For an aircraft that seats something on the order of about 40 passengers, you're looking at a $10 million machine to be really cost-effective.

It's going to take a while for this machine to get down in that range, perhaps.

Mr. **Torricelli**. Mr. Muldoon—

Mr. **Muldoon**. On the issue of cost, Mr. Torricelli—

Mr. TORRICELLI. I was going to ask you a different question, sir.

Mr. MULDOON. Okay.

Mr. TORRICELLI. You and I are going to talk some regional issues here for just a minute.

Have you examined sites in the New York Metropolitan Area in which you might operate?

Mr. MULDOON. We're in the process of looking at waterfront sites around Manhattan.

Mr. TORRICELLI. Is it—is your initial assumption that we're talking about pier operations?

Mr. MULDOON. Yes. The sites would require a relatively modest landholding, three, four acres.

Mr. TORRICELLI. Three or four acres.

Mr. MULDOON. Yes.

Mr. TORRICELLI. How many planes are you anticipating you would need to be able to operate off a site to make it effective as a transportation center?

Mr. MULDOON. The first study that was done by—I'm trying to think of the consultant—Hoyle-Tanner, indicated to fully exploit the metropolitan area, you would need six or seven sites scattered through Bergen County, Central Manhattan and other locations in the outlaying areas. We're not convinced of that. We're, I think, predisposed at this point to think that a Manhattan site, large enough, could capture a significant volume of the city-center/city-center traffic—

Mr. TORRICELLI. So you're thinking of a sole site or—

Mr. MULDOON. Initially.

Mr. TORRICELLI. Initially a sole site—

Mr. MULDOON. And also sites at the individual airports to—to accommodate this commuter activity that today chokes up the landing slots at each of the main runways.

Mr. TORRICELLI. So, therefore, there's two elements of this, a dedicated site for tiltrotor and planning some of the existing airports to accommodate tiltrotor with greater capacity?

Mr. MULDOON. Correct. Correct.

Mr. TORRICELLI. I see.

Have you had inquiries from carriers now operating out of New York airports, of inquiry of how it is you would conduct this traffic?

Mr. MULDOON. No, not really. The consultant that did the initial study contacted several aircraft operators—airline operators and didn't get much in the way of interest at that point in time. It seems—

Mr. TORRICELLI. Are you—

Mr. MULDOON. —that the short-haul operators are interested in perpetuating their own operation.

Mr. TORRICELLI. We share a noise difficulty in our respective professions. Is there a—are you convinced this is advantageous for that problem?

Mr. MULDOON. Yes, yes. The machine that we've viewed so far is quite quiet in its operation and, as I indicated in my testimony, we would argue that any larger development maintain that quiet neighborly operation.

Mr. TORRICELLI. What kind of a separation from a tiltrotor-dedicated facility you're likely to have to have from the public so as not to create a new noise problem? For example, if it's on a pier, how far is it likely to have to be located away from populated areas?

Mr. MULDOON. My guess is half a mile.

Mr. TORRICELLI. And you're anticipating using different FAA air traffic controls so you can use the river as approaches?

Mr. MULDOON. Absolutely, absolutely.

Mr. TORRICELLI. And what—to what distance would you anticipate this would operate in the New York region, cities of what distance? Are we basically talking about replacing Boston-Washington shuttles?

Mr. MULDOON. Yes. We've looked at a market represented by city pairs no further than 300 miles apart. Assuming only that a portion of the business travelers would be willing to pay a premium for that city-center/city-center operation, we estimate that from 5- to 8 million passengers in the year 2000 would be—would avail themselves of tiltrotor services.

Mr. TORRICELLI. As far away as 300 miles?

Mr. MULDOON. That's Boston, Washington—

Mr. TORRICELLI. And that is, in your estimation, 19 percent of all takeoffs and landings in the three airports today?

Mr. MULDOON. No, that's 44 percent of the takeoffs and landings and represents 19 percent of the passengers.

Mr. TORRICELLI. I see.

Mr. MULDOON. The short-haul market are basically smaller aircraft.

Mr. TORRICELLI. Forty-four percent of takeoffs and landings?

Mr. MULDOON. Serves cities 300 miles—

Mr. TORRICELLI. Are you anticipating that you would influence the economics of these judgments by—while making it as inexpensive as possible to use tiltrotors to make it somewhat more expensive?

Mr. MULDOON. Absolutely, absolutely.

Mr. TORRICELLI. I would hope so. Very interesting.

Mr. Campbell. Mr. Campbell's gone. Mr. Rohrabacher.

Mr. ROHRABACHER. I'm the one with the beard, Mr. Chairman.

Mr. TORRICELLI. Republicans all look alike.

[Laughter.]

Mr. ROHRABACHER. Coming at this—coming at this from another perspective and another coast, I might add that we have our own problems in the West and we have many, many small airports that were built, especially during World War II. In my own area, we have Torrance Airport, for example. We have Long Beach Airport. We have many other smaller airports that could certainly be brought into play to provide transportation for these commuter transportation for people to Bakersfield and San Diego and different places, San Jose, if this type of technology was developed and if the tiltrotor technology actually was commercialized.

So I am very optimistic and I join the chairman, who has now left, but I join his excitement over the possibility of tiltrotor technology, but I need to ask a few questions, perhaps not as friendly questions as the chairman, but still questions that need to be answered.

I'll just leave this up to the committee. Wasn't the 747 and the DC-3, weren't those projects basically developed by private industry and not with the—there wasn't first a military prototype and military development? And why is this project different than those major aircraft?

Mr. Finley. It probably won't be different if you can get somebody to take that first step, but this airplane, based upon the costs, they're looking at it now is going—and the size is going to take such an awesome first—to borrow my kid's word—such an awesome first order that there's going to have to be more than a couple of people step up to do it and it would probably, as Boeing bet the company on the 747, I don't know that they want to do it again. That's where you're coming from.

Mr. Rohrabacher. But you don't think there would be any corporations that would be willing—I mean, 747 and the DC-3 proved to be the most—707, we know, came from a military tanker and—

Mr. Finley. What you're talking about is a $25 million airplane that only carry about 10,000 pounds. That really smells bad in the cargo business. So you've got to have more milk to float it on. I'm saying, we're willing to take a look at it, but our order, as I told you, would be in the neighborhood—and incidentally, the West Coast is an easier solution. We've looked at it very much, if you'll keep your airports past 10 o'clock.

Mr. Rohrabacher. Right.

Mr. Finley. So we look at our order numbers and we're extremely interested. But unless they can tie themselves, the American Eagles or those sorts of things, you're talking about commuter airplanes, so they've got to tie themselves to the big fleets just like we do, I suggest

Mr. Flater. I'd also point out the fact that this is a fairly radical departure from existing technologies, compared to the DC-3 and the 747.

Mr. Rohrabacher. Well, now I keep hearing that if we don't do this, that there's the threat of the Japanese stepping in and we'll end up spending yen or buying these aircraft with yen, but no one really believes the Japanese are going to buy these or develop them through their own military, do we? I mean, we're just talking about companies in Japan willing to put up development costs that our companies may not be willing to put up.

Is that right?

Mr. Flater. First of all, I don't think—and I'm speaking now from—on the basis of being an American citizen and not knowing the Japanese system—I don't think other manufacturers have to deal necessarily with the FAA issues that we do so they can develop a component or a piece of equipment and put it in service elsewhere in the world, develop that time, and once it's there, then import it into this country.

Mr. Rohrabacher. I see that the—it says here that the potential market for—civilian market for tiltrotor aircraft is between 1200 and 1500, is that right? Or is it bigger than that? Has there been any estimate of the civilian market?

Mr. Finley. I suggest that that has to come from—

Mr. Rohrabacher. Okay, sorry about that. Well—

Mr. Finley. —someone else than this table.

Mr. Rohrabacher. Let me note that Northop Corporation put a billion dollars out to develop the F-20, as we know, and—which turned into a disaster, unfortunately. However, it was willing to put out its money and that was for a military aircraft, but I guess what we're hearing today is that our major corporations are not willing to put out that same type of commitment for a civilian aircraft.

Mr. Finley. I don't know that that's true. They're looking at the HST, all of those things are on everybody's plate right now. I don't know that that's true, but they've got to see the market out there. The market for the supersonic transport now is in the numbers of 400, as I understand. So you can see that even the expense that that airplane has—it's going to take—studies go out, say, that this airplane requires considerably more numbers than that to make it, pardon my expression, smell good, so it's a—

Mr. Rohrabacher. I would just close by saying that I—I would think that this new technology offers just exciting new potential for not only the East Coast, but the West Coast, and I am not certain whether or not the American military has to put this into—to procure billions of dollars worth of the aircraft. Certainly, the fact that we are spending money now in research and development—I think it's a good investment, at least in the research and development phase and I think—I will predict that although there's reasons to be pessimistic about some of these things, I predict that this technology is so exciting and offers so much potential, considering the noise factor that every single city that I know of is going through, every single that has an airport that I know is going through this noise problem, that this would just contribute greatly to eliminating that problem and contribute greatly to the crowded conditions at the big airports where we don't need to have commuter traffic coming out of those big airports.

So I'm excited about it and I'm very pleased and thank you very much for your testimonies that provide us some insights into also some of the challenges we have to overcome before this potential is put to use.

Thank you very much.

Mr. Glickman. [presiding] I came late, so I don't have any questions other than indicating that I support this both militarily as well as civilian-wise. I think that we're not going to be building any more airports in this country—maybe the Denver Airport is the last one, but major airports are probably a thing of the past. You know, there may be a few exceptions and this airplane offers us enormous flexibility. We're talking about wayports now. We don't need wayports. We have airports all over this country of ours that are not being used. One of them is my hometown, Wichita, Kansas. One strip is 10,300 feet. The other is 7300 feet. They're wide enough for simultaneous ILS takeoff and landings and hardly anybody uses it.

Oklahoma City, Omaha, Des Moines, Birmingham, Lincoln. I mean, there are just hundreds of airports that are available to use. What we need are the kinds of airplanes that can operate flexibly where there's high-density traffic and without building new airports. That's why this thing is so exciting.

We'll do our best to keep us on track. We thank you for being here.

Mr. TORRICELLI. The next panel is a panel of developers. Mr. Edward Renouard, the Executive Vice President of Boeing Helicopter; Mr. Leonard Horner, President of Bell Helicopter Textron; and Mr. Cliff McKeithan, Director of External Affairs, Georgia Institute of Technology and Director of the NASA/DOD/FAA Tiltrotor Study, and I think the way we will do this panel is we will start with Mr. Renouard and then we will go on with Mr. Horner and Mr. McKeithan.

I would tell all of you that your entire statements are in the record. You need not feel compelled to read the whole thing. I promise you, they will be in there. So if you could summarize, it would expedite it for both you and for us, and we'll start with you, Mr. Renouard.

STATEMENTS OF EDWARD RENOUARD, EXECUTIVE VICE PRESIDENT, BOEING HELICOPTERS; LEONARD HORNER, PRESIDENT, BELL HELICOPTER TEXTRON, INC.; AND CLIFF MCKEITHAN, DIRECTOR OF EXTERNAL AFFAIRS, GEORGIA INSTITUTE OF TECHNOLOGY AND DIRECTOR, NASA/DOD/FAA TILTROTOR STUDY

Mr. RENOUARD. Thank you very much.

Mr. GLICKMAN. I might just say that as a—as one of my constituents, my largest—the largest employer in the State of Kansas is the Boeing Company and particularly in my own city of Wichita, so I'm particularly delighted to have you here.

Mr. RENOUARD. Thank you, sir. It's—very pleased to be here and I'm very familiar with Wichita and it's a great city.

I'm very pleased to testify before your subcommittee and represent the Boeing Company and, more specifically, Boeing Helicopters, which is the division within Boeing that's responsible for the development of the tiltrotor, along with Bell Helicopters.

Our team at Boeing Helicopters is very excited about the prospects with this revolutionary new technology. We believe we are on the cutting edge of something that will change the way people fly in the immediate future. This new technology will have a tremendous positive impact on all branches of the military, we believe, as well as other government agencies, such as the Coast Guard, Federal Emergency Management Agency, Drug Enforcement and even the White House.

I'd like to summarize some of the V-22 flight test program which would lead some credence to the previous speakers, and hopefully the future ones, on how we're doing on the program. As most of you in the room know, the United States has over three decades of tiltrotor experience. The V-22 is the advanced, high-tech offspring of the successful XV-15, which has flown over 800 hours with over 2500 conversions.

Many of you may remember the XV-15 this past spring when it landed on the lawn in front of the U.S. Capitol building, which was during another similar hearing before the Subcommittee on Aviation, Committee on Public Works and Transportation.

Development of the V-22 has resulted in the most thorough testing program ever undertaken for a rotorcraft. Prior to full-scale development, nine models were wind tunnel-tested in nine facilities for more than 9000 hours. The carbon fiber wings were fabricated and tested separately, as were the major carbon fiber fuselage sections.

Large-scale rotor tests were conducted, as were numerous lesser-designed support tests. Following 46 months of design, tooling, development, facilities construction, fabrication and component testing, the first V-22 flew last spring on March 19, 1989.

In recent years, the prime contractors, Bell and ourselves, have invested over 200 million of our own money, the company's money, on the tiltrotor. But just as importantly, scores of subcontractors have also contributed many millions of dollars to the contribution for this major technology improvement.

To date, the V-22 flight test program is one of the more successful ever managed by the Naval Air Systems Command. Four prototype Ospreys have now flown 178 hours and 177 flights at sites in Delaware and in Texas, including a 1200-mile cross-country flight last May when we flew from Ft. Worth back to Wilmington, Delaware.

Seven hundred total operating hours have now been logged. Not only has the program accomplished its major test objectives for this stage of the program, but it has also identified and helped solve some complex problems along the way. The four V-22s, each continue to accumulate valuable flight test data, and demonstrate excellent potential for the aircraft's specified missions.

We have now completed the exploration of the initial flight envelope, attaining air speeds in excess of 290 knots and altitudes up to 15,000 feet. The flight test crews are very please with the handling qualities of the aircraft and vibration levels, which are always a challenge in rotorcraft, are well within the government's specified limits.

To sum up the flight test program to date, the tests are proceeding very well. There have been no technical show-stoppers uncovered and with initial envelope expansion complete, we expect no show-stoppers in the future. By the time the government goes forward for a production decision, we'll have completed 80 percent of the testing, including all of the critical test parameters. We believe the V-22 program is definitely in line with the fly-before-buy concept.

I'd like to talk a little bit about the validated requirements for the V-22 with the fast-moving world events that changed the political landscape and the consequent altered threat to peace, the need for the rapidly deployable V-22 tiltrotor has increased, not decreased. We read daily of international hot spots that could potentially erupt into low-intensity conflicts for which the V-22 is ideally suited. The flexibility and cost-effectiveness of the tiltrotor concept is evident from the military mission requirements that can be met with such an aircraft.

In the very beginning of the V-22 program, they had 10 military missions. They've now added an additional 28 military missions that they believe can be solved with the V-22.

It is not only the best platform in today's altered threat environment, we believe it is also the most cost-effective. As Representative Curt Weldon just testified, the latest and most comprehensive analysis of the V-22 program has just been completed by IATA. This cost and operational effectiveness analysis, which was requested by Congress, commissioned by the Office of the Secretary of Defense and done by the Institute for Defense analysis, clearly shows the V-22 is more cost-effective than any helicopter alternative for the missions originally identified by the four Services.

There are national economic benefits for the V-22 and we believe that the state of the art enabling technologies developed by both the primes and the subcontractors will have an impact far beyond the V-22 as they mature and are used in other industries, thus broadening our nation's industrial base and creating more jobs.

Without estimating the spin-off technologies, we anticipate that commercial production of the V-22 derivative will help maintain many thousands of jobs in America which, in turn, will generate millions of dollars in increased tax revenue.

During my testimony last April before the Aviation Subcommittee, I made a statement which I would like to repeat here. Although the V-22 is a key step on the road to widespread use of civil tiltrotors to ease airport congestion and enhance our transportation system, it is not possible to merely repaint or tweak the military version in order to produce a commercially viable tiltrotor alternative. Military V-22 requirements for battlefield survivability, Marine contingency operations, shipboard compatibility and joint special operations increase costs and reduce revenue payload relative to a practical civil tiltrotor. In addition, prior to successful civil tiltrotor and air traffic control system, noise abatement issues, airport management and numerous other problems must be addressed and must be resolved.

It appears from our studies there is a significant potential market for civil tiltrotor, but much most be done on infrastructure resolution, as well as solid acceptance by our potential customers. As we say at Boeing, we do not launch new airplane programs, our customers do.

There have been many studies on the required attributes of a commercially viable civil tiltrotor in the systems in which it must operate. These studies further reinforce the need to make substantial changes to the V-22 before it would be appropriate for commercial applications. However, we believe that early risk reduction, technology integration, manufacturing experience, field operations, safety and reliability data provided by flight tests, production and operational deployment of the V-22 are necessary precursors to a successful civil tiltrotor.

Mr. Chairman, I appreciate this opportunity to discuss the V-22 and its future. I believe it represents a significant new capability for the military, as well as the means to help solve the critical commercial aviation challenges facing the United States and the nations of the world.

Thank you for this opportunity.

[The prepared statement of Mr. Renouard follows:]

STATEMENT OF

EDWARD J. RENOUARD,

EXECUTIVE VICE PRESIDENT AND GENERAL MANAGER

BOEING HELICOPTERS

BEFORE THE

HOUSE COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY

SUBCOMMITTEE ON TRANSPORTATION, AVIATION AND MATERIALS

I am pleased to testify before this Subcommittee and represent the Boeing Company and more specifically Boeing Helicopters, the division with the overall management responsibility for development of the tiltrotor.

My team at Boeing Helicopters is very excited about the prospects for this revolutionary new technology. We believe we are on the cutting edge of something that will change the way people fly in the immediate future. Not only that, this new technology will have a tremendous positive impact on all branches of the military, as well as other government agencies such as the Coast Guard, the Federal Emergency Management Agency (FEMA), the Drug Enforcement Agency (DEA), and even the White House.

The civilian applications are numerous as well, but since they will be discussed by Mr. Jack Horner, I will limit my remarks to a different aspect.

There is one important element of the civilian area that I would like to discuss rather briefly before I get into my comments. It is a personal observation of mine that as yet, is only a hypothesis.

I have watched with considerable interest the development and growth of the Metro system in and around Washington, D.C., and the impact it has had on the communities where Metro stations have been built. Even from the air it is possible to observe the effects, for example, new businesses of all kinds, apartment buildings and in general, an overall economic revival within the immediate area. I believe the tiltrotor has the same potential, not only for developed nations like the U.S., but for developing nations which do not have the financial resources necessary to build an infrastructure required to support a major airport.

The tiltrotor, I believe, will make it possible for these smaller, developing nations to move products within the country, as well as to neighboring countries. This is particularly true in areas with jungles, dense forests or mountains that make the building of runways physically prohibitive. I have asked my staff to research this potential application for tiltrotors, and hopefully in the future we will be able to put some meat on this hypothesis.

However, the revolutionary aircraft which Jack and I are discussing here today cannot become a reality until the military version has been successfully developed and proven.

Now, I will review the V-22's development status, technology, recent restructuring, national economic benefits and, briefly, the military program.

The V-22: An Important U.S. Technology

The U.S. has over three decades of tiltrotor experience. The V-22 is the advanced high-tech offspring of the enormously successful Bell XV-15 which has flown over 800 hours with over 2,500 conversions. Many of you may remember the XV-15: this past spring it landed on the lawn in front of the U.S. Capitol Building.

Development of the V-22 has resulted in the most thorough testing program ever undertaken for a rotorcraft. Prior to Full Scale Development (FSD), nine models were wind-tunnel tested in nine facilities for more than 9,200 hours. The carbon fiber wings were fabricated and tested separately as were the major carbon fiber fuselage sections. Large scale rotor tests were conducted as were numerous lesser design support tests. Following 46 months of design, tooling, development, facilities construction, fabrication and component testing, the first V-22 flew on March 19, 1989.

In recent years, the prime contractors have risked over $200 million of their own monies on the tiltrotor. But just as importantly, scores of subcontractors scattered throughout the United States have also risked millions of dollars of their own funds. These companies, large and small, have developed unique technologies which contribute to the success of the V-22. The synergism of all members of the Osprey team working together has resulted in a quantum leap in aerospace technology that promises to keep America first in this important field -- if we are allowed to pursue it. The momentum is clearly ours . . . for now.

The Successful V-22 Development Program

To date, the V-22 flight test program has been one of the most successful ever managed by the Naval Air Systems Command. Four prototype Ospreys have flown 178 hours in 177 flights at sites in Delaware and Texas, including a 1,200-mile cross-country flight last May. Seven hundred total operating hours have been logged. Not only has the program accomplished its major test objectives for this stage of the program, but it has also identified and helped solve complex problems along the way.

The four V-22s each continue to accumulate valuable flight test data and demonstrate excellent potential for the aircraft's specified missions. We have now completed the exploration of the initial flight envelope, attaining airspeeds in excess of 290 knots and altitudes to 15,000 feet. The flight test crews are very pleased with the handling qualities of the aircraft; and vibration levels, always a challenge in rotorcraft, are well below the governments specified limits.

> Aircraft #1 has completed the initial flight envelope expansion to 250 knots and 2.3 g maneuver load factor. It has accumulated over 58 hours in 79 flights. It will

continue to expand the tiltrotor's unique flight envelope during the remainder of 1990, performing tests to evaluate aeroelastic stability, height-velocity, and high angle of attack maneuvers.

Aircraft #2 was the V-22 which flew a cross-country ferry flight 1,200 nautical miles from Texas to Delaware. Last April it completed a highly successful series of government flight tests, winning the praises of the three Government evaluation pilots. Number two has 83 hours in 62 flights. It continues to perform its primary function in the test program of developing and qualifying the Osprey's fly-by-wire flight control system, the first such system to be incorporated in an operational rotorcraft.

Aircraft #3, the most recent Osprey to join the flight test program, has 6 hours in 10 flights. Like Aircraft One, it will continue to open the tiltrotor's flight envelope and conduct vibration and load surveys.

Aircraft #4 has logged nearly 31 hours in 26 flights and will continue propulsion, performance and avionics integration flight testing in early August, following scheduled gearbox inspections and additional avionics and instrumentation installations.

During the course of the flight test program we encountered anticipated challenges, ones we had planned for, and have successfully met them, even though the program is extremely complex because the V-22 tiltrotor must operate within three flight envelopes; helicopter, transition and airplane.

To sum up the flight test program to date -- the tests are proceeding very well. There have been no technical showstoppers uncovered and with initial envelope expansion complete, we expect none in the future. By the time the government goes forward for a production decision we will have completed 80% of the testing, including all the critical test parameters. The V-22 program is definitely in line with the "fly-before-buy" concept.

The Strong Potential International & Civil Market

As reported in a recent industry newsletter (Helicopter News, July 13, 1990), Ishida Aerospace Group of Japan which is developing its own competing commercial design, the TW-68 tiltwing aircraft. They are forecasting a production run between 1997 and 2005 of approximately 300 aircraft. They estimate one-third will be taken by the North American market and the balance by Pacific Rim nations and possibly the Middle East.

The point is, there is a potentially strong international market for the tiltrotor, however I wish to interject a word of caution. Boeing does not start new airplane programs, our customers, the airlines, do.

During testimony on April 25 before the Aviation Subcommittee, witnesses presented statements characterizing Western European air travel as coming to a "near standstill" within a decade, and portraying the serious transportation congestion in Japan. Here in the United States, the 74% forecasted growth in enplanements in this decade promises to increase the number of seriously congested airports. Yet, only three runways are expected to be added to the top ten airports by 1997 and only one new airport (Denver) is scheduled to be built.

The need to alleviate congestion exists now, and the only foreseeable way to accomplish that task is with the tiltrotor.

Validated Requirements for V-22 -- The Cost Effective Solution

With fast moving world events changing the political landscape and the consequent altered threat to peace, the need for the rapidly deployable V-22 tiltrotor has increased, not decreased. I read daily of international hot spots that could potentially erupt into low-intensity conflicts for which the V-22 is ideally suited. I know of no one who claims terrorism is on the wain, or that there will not be another Panama, or Grenada, or Tehran, even though the overall threat of global nuclear war has decreased.

The flexibility and cost effectiveness of the tiltrotor concept is evident from the military mission requirements that can be met with such an aircraft. In the very beginning of the V-22 program, ten military missions were identified by the Joint Services and the aircraft has been designed specifically to meet these requirements. These mission requirements have withstood rigorous scrutiny and analysis over the last nine years and still remain valid. An additional 28 mission requirements that can be met by the V-22 have been identified by the Defense Department.

The V-22 is not only the best platform in today's altered threat environment, it is also the most cost-effective.

An Affordable Restructured Program is Within Reach

The latest and most comprehensive analysis of the V-22 program has just recently been completed. This Cost and Operational Effectiveness Analysis, requested by Congress, commissioned by OSD and done by the Institute for Defense Analysis clearly shows that the V-22 is more cost effective than any helicopter alternative for the missions originally identified by the four services.

The major finding of the IDA study was the fact that a smaller, restructured V-22 program would still be significantly more cost effective than any alternative, and would cost less than any alternative both in the near years and over the life of the program.

The V-22: A Good Investment of Public Capital

This spring, Senate Armed Services Committee Chairman Sam Nunn gave a series of speeches on the floor outlining his vision of where the United States should go with its defense strategy. Two poignant statements bear repeating here. Senator Nunn said we must "put greater emphasis on innovative concepts . . . to maintain our technological superiority. **This applies particularly to systems and capabilities that offer the prospect of 'breakthrough' or 'leapfrogging capabilities"** (Congressional Record, April 19, S4454); and **"we [should] promote technologies that have a useful application in commercial industry as well as in defense applications, so the overall cost of new technology is affordable for both sectors"** (Ibid, April 20, S4657).

Not only is the V-22 tiltrotor a good investment for the military and, eventually, for commercial aviation, but also for other civil applications. Recently retired Coast Guard Commandant Paul Yost told a Congressional committee that the V-22 was "the answer to a Commandant's prayers." Its versatility and speed in Coast Guard search and rescue missions would require only one aircraft, rather than the two now used. In drug interdiction efforts, the V-22 can easily track, follow and intercept, in the air and on the ground, the airplanes drug runners use to transport their deadly cargo. The previously mentioned IDA study concluded the V-22 would be very cost effective in these types of missions. As a Presidential transport, the V-22 can safely move the President from the White House to distant points in a fraction of the time it now takes, and with greater reliability and safety.

I know of no aircraft in the history of aviation that offers the all-around versatility and multi-mission capability of the V-22. It is the culmination of over three decades of research and development that is exclusively American. But it is also the commencement of a whole new dimension in aviation. Just as the military use of large multi-engine aircraft led to the acceptance of jet transports, the V-22 program is the bedrock of expansive use of tiltrotors in the civil and commercial world.

National Economic Benefits from the V-22

On April 25, 1990 in testimony to the House Aviation Subcommittee, the members learned that if America develops the tiltrotor, we could benefit from a $10-15 billion positive trade increase by the year 2010 to offset our trade deficit. The other side of the token is the trade deficit we will incur if we are forced to buy our own technology abroad. But more than that, the state-of-the-art enabling technologies developed by both the primes and the subcontractors will have an impact far beyond the V-22 as they mature and are used in other industries, thus broadening our nation's industrial base and creating more jobs. Without estimating the spin-off technologies, we anticipate that commercial production of a V-22 derivative will help maintain many thousands of jobs in America which, in turn, will generate millions of dollars in increased tax revenues.

The V-22 in Relieving Air Traffic Congestion

Jack will address the air traffic congestion issue. To restate the obvious, air travel has increased dramatically in the past and no end is in sight for the future as humankind becomes increasingly mobile. The fall of the Berlin Wall and the collapse of the Iron Curtain is certain to exacerbate the strains under which the world's air traffic system operates. Truly, we are becoming a world without borders.

Summary

During my testimony last April before the Aviation Subcommittee, I made a statement I wish to repeat here. Although the V-22 is a key step on the road to widespread use of civil tiltrotors to ease airport congestion and enhance our transportation system, it is not possible to merely repaint or tweak the military V-22 to produce a commercially viable tiltrotor aircraft. Military V-22 requirements for battlefield survivability, Marine contingency operations, shipboard compatibility, and joint special operations missions increase cost and reduce revenue payload relative to a practical civil tiltrotor. In addition, prior to a successful civil tiltrotor, an air traffic control system, noise abatement issues, airport management, and numerous other problems must be addressed and resolved.

There have been many studies on the required attributes of a commercially viable civil tiltrotor and the systems in which it must operate. These studies further reinforce my statement above on the need to make substantial changes to the V-22 before it would be appropriate for commercial applications. However, we believe that early risk reduction, technology integration, manufacturing experience, field operations, safety and reliability data provided by flight test, production and operational deployment of the V-22 are necessary precursors to a successful civil tiltrotor.

For example, the V-22 flight test and operations will efficiently provide much of the data and experience needed to develop and refine FAA certification criteria for civil tiltrotors. The V-22 will provide the necessary experience in the integration and operations of a number of key enabling technologies which are mandatory for a viable commercial tiltrotor program.

Mr. Chairman, I appreciate this opportunity to discuss the V-22 and its future. I believe it represents significant new capability for the military as well as the means to help solve the critical commercial aviation challenges facing the United States and nations of the world. Again, thank you.

TEN ORIGINAL V-22 MISSIONS

MARINES	AMPHIBIOUS ASSAULT TROOP LIFT
	AMPHIBIOUS ASSAULT EXTERNAL LIFT
	LAND ASSAULT TROOPS
	LAND ASSAULT EXTERNAL CARGO
NAVY	COMBAT SEARCH AND RESCUE
	SPECIAL WARFARE
	FLEET LOGISTICS SUPPORT
AIR FORCE	LONG-RANGE SPECIAL OPERATIONS
ARMY	TACTICAL MOBILITY
ALL SERVICES	WORLD-WIDE SELF DEPLOYMENT

OTHER V-22 MISSIONS

MARINES

Sustained Operations Ashore
Preposition Operations
Contingency Operations
Aerial Tanker
Command/Control
Airborne DASC
Electronic Warfare
Clandestine Pathfinder
Airborne Early Warning
Night Station SAR

NAVY

Antisubmarine Warfare
Passive Electronic Warfare
Carrier Onboard Delivery
Mine Warfare
Vertical Onboard Delivery
Aerial Tanker
OTH Targeting
Mine Countermeasures

AIR FORCE

Air Rescue
Lt. Intratheater Transport
Aerial Tanker
Gunship/CAS/FAC
Missile Site (SAC) Support
Aeromedical Evacuation
Joint Emergency Evacuation
Range Support
Oper. Support Airlift

ARMY

MEDEVAC
Special Operations
Priority Logistics Support

CIVIL

High-Density Passenger
Corp. Executive Transport
Public Service
Drug Enforcement Agency & Customs
Cargo Package Express
Resource Development
Emergency Evacuation
Drug Interdiction

COAST GUARD

Maritime Safety (Search & Rescue)
Maritime Law Enforcement
Maritime Defense

Mr. **Torricelli**. Thank you very much.

Mr. Horner.

Mr. **Horner**. I'm Jack Horner, President of Bell Helicopter Textron, and it's a pleasure to be here, sir, and to speak today on this technology, and we're really here talking about a system to move people and goods.

I believe the statement of transportation policy and Secretary Skinner, "The focus of transportation programs should be moving people and goods, not simply accommodating vehicles or modes. In some cases, investments in alternate modes may be the best means for alleviating congestion." And in the world that we're looking at, I believe the tiltrotor meets that requirement because, as we've heard here, most of the movements are short-haul, and if you look at the total international marketplace and look at the infrastructure that exists, in which this country, we're very blessed by having a solid infrastructure, most places it doesn't and tiltrotors apply because what we're looking at is the building of airports and runways, not only within the U.S., but throughout the world.

As we've heard, the civil tiltrotor could increase airport capacity and, therefore, revenue. As we've heard, the civil tiltrotor can extend the economic life of current airports by not having to add airports. It's interesting that there was a study written by the California Commission on Aviation and reports in January 31 that reports—talks to the use of tiltrotors that extends current airports. It affords flexibility and destination sites, as we've heard, because you only need four to five acres of land.

It has a low environmental impact because of noise and space requirements and it requires a modest infrastructure relative to new airports. I read in the Chicago paper the other day five billion to six billion for a new airport. You could put the whole system in the Northeast Corridor for less than that, including the development and the procurement of the air vehicles.

It fosters demographic shifts, as we noticed. Any new transportation system, such as a rail system or airports, business gravitates to that point, and it provides regional and international access to small areas, where you have small airports.

Currently, investment, $2 billion by the military, and going to 2-1/2 and well over $200 million by ourselves and our subcontractors. There are some, what I call, barrier issues, development of customer confidence, which you heard from the operators, the infrastructure development, which you've heard discussed, the technical risk and the financial risk.

I can't emphasize how much on the customer confidence issue. I've talked to customers throughout the world, not just the United States. I've talked to American Airlines, Delta Airlines, Midway, Business Express, Pan Am. They have all written letters in support of tiltrotor technology, but they want to see the proof of the pudding, as I call it, the stamp of approval by the U.S. Government.

An example having been, as you mentioned, the 707. The helicopter, numerical controlled machine tools. The turbine-powered helicopter itself. There were 200 aircraft bought for the U.S. Army, turbine-powered helicopters. Through that stamp of approval, Bell Helicopter alone exports over $450 million worth of product a year.

That stamp of approval proved turbine-powered technology in the helicopter.

We need the government experience through V-22s. Commercial demonstrator will be needed. The utilization of part of the development program V-22s can be a beginning to move goods, not people. A pressurized is the next step, to put a commercial aircraft that has got capability of moving people.

At that point in time, with the government having flown, that is the Marine Corps, the Air Force and, I believe the Navy and the Army, flying V-22s, demonstration that we have a system in place that will accept it. Then I believe the Bell and Boeing team can put together a customer base that will allow us to release a production order in the area of 200 and 250.

The infrastructure was discussed before by the chairman. We need air traffic control and vertiports. There are marketing studies going on right now in 15 different cities looking at infrastructure. The technical risk, I believe, we're doing well on the basic aircraft. We still need to adapt an airplane to a commercial aspect.

The financial risk is probably one of the ones that's the most severe and has been discussed here before. I am concerned as an individual and also as part of Bell Helicopter. We look at the aerostructure, air—and say, man, what a fantastic success in the commercial business. The facts are the Boeing Aircraft Company is the most successful commercial operator in the—manufacturer in the world and, in my estimation, the only one. We only read in the paper this morning about the problems of McDonnell Douglas. Airbus is fully controlled and subsidized through the government agencies. Convair and Martin are out of the business. Lockheed's out of the business. Fairchild is in Chapter 11. The small—the Cessnas, the Beeches, the Pipers are all—have all either been absorbed into other companies with write-offs or are basically in serious trouble, such as Piper.

Eighty percent-plus of the commuter-type airplanes are being bought internationally. The problem has been referred to as patient capital. Somebody mentioned the DC-3—I think interest rates were in the 2 percent category in that particular time.

There is no basic commercial helicopter that has been operating that has not had a derivative of a military, except maybe the Robinson. It is a complex aircraft.

I believe we need a partnership and a national civil tiltrotor system, a partnership between government and industry. The leader should be the Department of Transportation. Congress should state that we need a national CTR goal. The Department of Transportation should establish policy and program management. NASA should provide technology base. FAA should put the infrastructure and industry will do the development of the production aircraft.

I believe that in fiscal '91, there should be money added to NASA for a two-year risk-reduction program to support the civil tiltrotor. Preliminary design work, wind-tunnel work, drag reduction. How do we make this V-22 a viable aircraft to add to the stamp of approval to go into the commercial world, and planning of a technology program?

I believe there should be the formation of a government/industry working team, a national tiltrotor transportation system. Maybe the Aviation Trust Fund is a source of funds to support this technology.

We're talking about something that's greater than just tiltrotor technology; we're talking about something that can create an export market and a world market to move goods and people that I believe is essential to go into the next century, not just the next decade.

We need a partnership between industry and government that's different than anything that's been done because we have laws in this country that preclude joint marketing efforts and joint development efforts. We need to have that type of a program.

Thank you.

[The prepared statement of Mr. Horner follows:]

TESTIMONY OF LEONARD M. HORNER
PRESIDENT, BELL HELICOPTER TEXTRON INC.

before the

SCIENCE, SPACE, AND TECHNOLOGY COMMITTEE
SUBCOMMITTEE ON TRANSPORTATION, AVIATION AND MATERIALS

> "We need to take full advantage of new and emerging transportation technologies." Samuel K. Skinner
> Moving America A Statement of National Transportation Policy, pg 10: February 1990

NEED FOR A CIVIL TILTROTOR (CTR) TRANSPORTATION SYSTEM

This hearing is about technology, applied to the problem of relieving airport congestion. For that purpose, tiltrotor offers aviation more promise than any technology on the horizon. This hearing is also about finding a new way of thinking about bringing a civil tiltrotor system into being. I hope to provide you with some new ways of thinking because, frankly, laissez-faire will not create a tiltrotor transportation system.

Secretary Skinner's policy statement on the future of the national transportation was an excellent start. Although it did not specifically recommend that a national tiltrotor transportation system be created, it explicitly mentioned the potential of tiltrotor technology, as a promising alternative. In a broad sense, the policy urged an examination of alternatives.

> **"The focus of transportation programs should be moving people and goods, not simply accommodating vehicles or modes. In some case, investments in alternative modes may be the best means for alleviating congestion and achieving other objectives in a transportation system, and resources should go to those alternatives if they represent a more cost-effective way to meet transportation needs."**
> Moving America (1990)

This is a perceptive message.

Today, for example the U.S. (and the rest of the world) is seeking to build more airports or more runways to accommodate more airplanes, using Aviation Trust Funds and private funds. When not prevented by environmental barriers, this process seems to be logical. However, the real need is not just accommodating more airplanes, but rather moving more people, especially short haul travelers. Since air travel is principally a short haul business, the tiltrotor should be examined. It can provide short haul capacity increase more cost-effectively and with less environmental impact. In fact, it might be appropriate to use the Aviation Trust

Fund (in which there is a several billion surplus) to support part of the creation of a tiltrotor system. This is justifiable as this use of these funds would provide significant relief of system congestion at less cost. (Tiltrotor ticket taxes for the Aviation Trust Fund would aid continued airport improvements while tiltrotor aircraft would require comparatively little investment in facilities.) NASA also could play an active development role as they are doing in preliminary efforts today for the National Aerospace Plane (NASP) NASA funding for NASP is reported to be $284 million so far. It is not too overstated to suggest that the outcome for this ambitious project may be frustrated if the NASP has no place to land for the lack of a tiltrotor system to help "decongest" the runways.

The Skinner policy highlighted several air transportation needs which implicitly seek tiltrotor solutions, including: the need for system capacity increase: the need for access by more communities to international air service: the need for environmental awareness: and the need for rural access to transportation.

POTENTIAL FOR MANY BENEFITS WITH CTR

Today's U.S. aviation system is regarded as a marvel of technology, efficiency and convenience. However, there are clouds on the horizon. Congestion and delay are an increasing problem. The last major airport, DFW was added in 1974. No further airports (with the possible exception of Denver) may be added in this century. Runway expansion or increased operations at any airport is seriously challenged by real environmental concerns. A tiltrotor transportation system, which could be in place by the year 2000, offers significant benefits to increase system capacity at lower cost than any alternative aviation possibility.

What is unique about the tiltrotor is that it is a turboprop aircraft that doesn't need a runway. With turboprop speed and pressurization, it can cruise at 10-18,000 foot altitude in uncongested traffic. Having helicopter-like low speed and hover qualities, it doesn't need a fixed wing slot for approach or on the runway. Therefore, it adds airport passenger capacity without adding runway space.

In providing a solution to the growing congestion of our national air transportation system, a tiltrotor (CTR) has these advantages.

A. CTR increases airport capacity

Today, 75% of all passenger flights travel less than 500 miles. In the United States 41% of flights arriving at the ten busiest airports come from less than 300 miles. Similar values hold true in Europe and parts of Asia. A principal reason for congestion is that short haul and long haul aircraft use the same runway space. For ranges of 75 to 500 miles, a tiltrotor transportation network would add a short haul service to existing airports requiring neither runways nor slots. Or, city-center to city-center service would avoid the airport completely. A tiltrotor means billions in additional revenue for major carriers. They would realize an economic leverage by using the runway slots, off-loaded by tiltrotor, for longer range flights which produce higher revenues.

B. **CTR extends economic life of the current airports**
As tiltrotor service relieves runway slot pressure, some investment planned for airport expansion might be reduced, postponed, or in some cases precluded. The Aviation Trust Fund would benefit in two ways. First, a reduced rate of capacity improvement, eases Trust Fund demand. Second, the taxes on tiltrotor fares would create more income than the tiltrotor system will need in infrastructure expense. New thinking about the congestion problem would suggest that it might be appropriate to use Aviation Trust Funds, which are dedicated to increasing system capacity, to support part of the creation of a tiltrotor system.

C. **CTR saves time for the traveler**
Over ranges of 75 to 500 miles, a tiltrotor promises to provide a passenger portal to portal time savings. This could be 2-4 hours per trip, compared with conventional jet transport, especially in city-center to city-center travel.

D. **CTR affords flexibility in destination sites.**
A 4.5 acre vertiport (0.1% of an airport's size) can handle two million passengers a year. Vertiports are sited at airports, over superhighways, on building tops, river piers or in clear suburban areas. As population shifts, a tiltrotor system adapts to changing transportation needs with low cost vertiports built in advance of growth.

E. **CTR has low environmental impact**
Vertiports require far less valuable land space than airports. CTR noise levels will meet Stage 3 rules. A CTR is considerably less noisy than a helicopter at takeoff and in cruise flight it produces much lower noise than same weight fixed wing aircraft. Because of its high angle approach and departure paths, a tiltrotor presents a small noise footprint, inconveniencing a relatively small area.

F. **CTR requires modest fixed infrastructure investment**
An estimated $4-6 billion is estimated for building one airport (assuming site is available). By comparison, a total tiltrotor system in the Northeast corridor, including aircraft development and production plus 18 vertiports would cost far less. Such a network of vertiports around New York, Washington, and Boston would serve a high percentage of the air travel on the Northeast corridor.

G. **CTR fosters demographic shifts**
Access to air transportation is the engine of economic development. A tiltrotor transportation system will spur development of new economic nodes, i.e. commercial or industrial population centers, around vertiports in now under-developed areas. This has been the history around airports. As capacity for air service at major airports becomes increasingly saturated, economic development would benefit from a tiltrotor reliever system. The effect would be a decentralizing of economic nodes to points of new development, remote from current airports.

H. **CTR provides regional and international air access**
Airports will not be located in rural areas but a vertiport can be put anywhere. This means that small or rural communities can gain access to regional or international airports for the economic benefits of trade and travel. Many small towns with Essential Air Service (EAS) may in future be denied access to slot limited airports. CTR can provide the economic advantage with non-runway aircraft.

DOD AND THE CIVIL TILTROTOR PROGRAM

The DOD investment, now exceeding $2 billion, has brought military tiltrotor technology to the point of production. The Bell-Boeing V-22 team has made major capital investments (estimated at $200 million) expecting a continued DOD program. CTR hangs on the outcome of the DOD program in Congress. With V-22 military production as a basis, later CTR development and introduction is logical.

THE "BARRIER ISSUES"

The Bell-Boeing V-22 team is convinced there is a large potential ahead for the civil application of tiltrotor technology. For the tiltrotor to fulfill its civil potential, elements that industry regards as barrier issues must be resolved. These include:

A. Development of customer confidence/acceptance,
B. Timely infrastructure development,
C. Reduction of technical risk, and
D. Reduction of financial risk.

The first issue, development of customer confidence, requires experience and demonstration. The second, timely infrastructure development, is a multi-faceted issue which is being monitored/orchestrated by the Federal Aviation Administration (FAA). The technical risk issue requires continued NASA activity over which this committee has jurisdiction. Financial risk is a subjective measure for which an acceptable level depends on significant progress in the other three issues. When the barrier issues are removed, the development risk may be reduced to an acceptable level. At that time, private industry would expect to fund the development of a civil tiltrotor aircraft. A notable caveat is that investments already made in the military program has weakened the financial capacity of the two partners.

The Customer Confidence Issue

The potential for tiltrotor aircraft has drawn strong interest in the civil aviation community. However, the tiltrotor lacks the credibility of experience which civil operators require as a basis for investment. There is a historic relation between military and civilian aviation. In technology developments and service usage, virtually every major airframe and engine flying commercially today has roots in military technology investments. For example, the flexible wing, a breakthrough technology pioneered on the B-47 and B-52, was used on the Boeing 707. It then became a standard civil industry technology. Nearly all current civil jet engines, "glass cockpit" technologies, fly-by-wire control systems and composite materials are based on DOD developments and military service use. The tiltrotor will be no exception. Military service experience will also be a source of pilots and maintenance people familiar with tiltrotor aircraft.

Air carriers are very conservative about adopting new technologies because they can afford zero risk in either safety or dispatch reliability. The marketplace is receptive to new or even breakthrough technologies. However, Bell-Boeing market surveys confirm that the user insists that such technologies be "wrung-out" by military operating experience. Potential operators want validated reliability, maintenance, safety, environmental (noise, vibration, pollution) and operating cost data. Operators point out that the conditions of aircraft financing vary directly with the level of past operating experience. With less operational experience, terms are more expensive. Until the time that service experience is gained, the operational risks of civil tiltrotor will remain too high for potential users. In this circumstance, the development investment risk is too high for industry, because the return on that investment is very time sensitive. It cannot wait for customer acceptance to evolve. After the V-22 gains military service experience, there will be a basis for rapid growth of the civil market.

Market development can be accelerated by the use of a phased demonstration program. The first demonstrator will be a certified V-22 development aircraft (under an existing MOU between DOD and FAA to certify while qualifying). This aircraft will perform revenue cargo operations to confirm reliability and maintenance characteristics. Initial demonstration locations will make small demands on infrastructure. The first unpressurized prototype would not be used for passenger carrying demonstration as this would be counterproductive. Exposure of passengers to a non-representative example would likely create a negative passenger reaction.

The second demonstrator, pressurized and designed for passenger comforts must be built to convince the market to purchase aircraft. When such a demonstrator is available, demonstrations will move to increasingly sophisticated environments. Vertiports in city locations and IFR operating capability will be added to prove CTR operating suitability. Full scale production of CTR aircraft will be based on getting enough launch orders to make the program risk financially acceptable. The production release will require orders of at least 200-250 aircraft. This initial release, and the rate at which production aircraft can be sold, depends on several factors. The most important of these is a prior service experience base with the V-22. Others include the rate at which infrastructure is developed, the operational success of initial CTRs, and external events which are beyond the control of either manufacturers or operators.

The Infrastructure Issue

Aviation experts point out that the rate of market development for CTR is a system problem, not simply a technology issue. A principal system issue is infrastructure development involving many pieces and many public and private interests. Unlike the introduction of a new fixed-wing aircraft, there is no the infrastructure in place. The CTR infrastructure development, including vertiports and a tiltrotor Air Traffic Control (ATC) system, is a major market driver. It will be a major factor in the timing for risk investments in aircraft development and production. As infrastructure is clearly beyond the control of industry, Federal effort will be needed in this "chicken and egg" situation.

A network of "well-located" vertiports is a vital element in maximizing the CTR's transportation benefits. Initial studies on vertiport location are now underway in 15 cities and regions in the U.S. and Canada. Actual construction, using local and Aviation Trust Funds, requires a plan in which all parties find benefits commensurate with their investment.

A fundamentally different ATC system is required. This addition to the ATC system needs to permit day/night IFR operation of CTR aircraft in and out of vertiports in high-density control zones and en route. It must operate without interfering with fixed-wing traffic. It should be easily possible to extend ATC to new vertiports when added in numerous city locations.

There are several infrastructure tasks which are now under consideration which must be completed by the FAA. These include:

A. **Air Traffic Control (ATC)**
The very difficult problem of developing and installing a fundamentally different ATC system is required. This ATC addition needs to permit day/night IFR operation of CTR aircraft in and out of vertiports in high-density control

zones and en route. It must operate without interfering with fixed-wing traffic. It should be easily possible to extend ATC to new vertiports when added in numerous city locations.

B. **Certification**
The standards for certification of a new type of aircraft must be finalized. An interim standard exists, but is yet to be verified by use.

C. **Operating Standards**
Criteria for operations and safety for CTR aircraft must be established.

D. **Training**
Criteria for training and licensing of CTR pilots and maintenance personnel must be established.

The Technical Risk Issue

Technical risks of developing a CTR are reduced by the DOD V-22 program experience. Civil use of that technology base presents significant new challenges and risks. Configuration changes from the V-22 would include a pressurized fuselage, which is a major task. Adapting the fly-by-wire control system and deleting many military subsystems are big technology steps. Other change may include power increase in the engine and drive systems. These are technical risks which could have very measurable effect on financial results for a CTR program.

Then comes certification. A CTR is unlike a new airplane or helicopter model, for which FAA certification criteria are well established. The FAA has established an interim airworthiness standard for certification of (powered-lift) tiltrotor aircraft. First certification will use a V-22 full scale development (FSD) program test vehicle. The CTR will be the first certification of a tiltrotor production aircraft. If this process proves to be lengthy, or requires major redesign and testing, the delay in deliveries would adversely affect the return on investment.

Because a CTR will be a new and relatively unknown type of aircraft, the civil aviation user will need considerable logistics support in the initial years of service. There are high costs associated with the required full range of product support. These include spares stockage, field support, and product guarantee/warranty liabilities. The impact is difficult to estimate but will be significant. Responsive logistics support has always been important, but with a new aircraft like the tiltrotor, it will be exceptionally critical to future sales.

The Financial Risk Issue

The financial risks for aerospace development and production are exceptionally long term in nature and require large amounts of up-front funds for development, tooling, facilities, and production inventory. A review of recent American civil aviation history is not encouraging. In spite of many notable achievements, the record indicates that the U.S. lead is slowly drying up.

There is only one major aerospace corporation in America today that is making an independent success of the civil transport market. The Boeing Company is, in fact, the only company in the world in this enviable position. Other major corporations have not fared so well. Convair and Martin dropped out of commercial production years ago, Lockheed quit more recently. McDonnell Douglas lost money on the DC-10 and is currently in financial difficulty between the MD-11 delays and military program losses. With Fairchild in Chapter 11, there is no modern regional aircraft (of more than 19 seats) manufactured in the United States. All are imported. In the U.S. regional aircraft fleet today, 96% of all aircraft over 20 place being of foreign origin. Grumman was not successful in the civil market, and sold its Gulfstream product which has since changed ownership four times. Piper is in difficulty, and LearJet has been sold three times. Beech was rescued by Raytheon and is not doing well on the Starship. Cessna, with a whittled down product line, was acquired by General Dynamics. Overall, an objective observer would question the current health and future outlook for the U.S. aviation industry.

The principle causes for the apparent decline of the U.S. aviation industry are high (and growing) development costs and the lack of "patient capital" (capital invested for long term technology benefit rather than short term return) in the financial community. Add to this the probable decline of Defense R&D expenditures, and the stage is set for further reduction in the number of new starts.

Looking abroad, the Airbus is not a financial success. However, European governments, like the Japanese government, are sources of "patient capital". They have been willing to fully subsidize the Airbus for development and partially support production pricing against currency fluctuation in expectation of an eventual day of program breakeven. European helicopter projects also have some form of government backing.

In the rotary wing industry, there are increasingly difficult and expensive challenges to be met in refining new technologies through flight testing. Unlike their simpler fixed-wing cousins, rotary wing aircraft, including tiltrotor, have particularly complex dynamics problems. These problems always dominate and often delay the development process. In resolving dynamics problems, there is a higher risk of a costly outcome (delay) than for fixed-wing aircraft. Government support is limited to valued but meager seed money in partially allowable Internal Research and Development (IR&D) funds. Looking to private capital, short term gain has more advocacy than does long term technological opportunity ("impatient capital"). Under these circumstances, it is becoming less and less possible for most companies to afford development uncertainties. This is especially true for helicopter and tiltrotor companies that are financially very small members of the aerospace industry.

This record of the civil aircraft industry's declining ability to stay afloat in a long economic boom is alarming. It is particularly troubling in that, with traditional thinking, there is no solution in sight. The U.S. has no mechanism for public support of high entry cost, moderate risk commercial development ventures in aviation (or any other field). Antitrust law is a further inhibitor as it effectively discourages risk sharing between companies who might otherwise join to assemble the critical mass of capital. While teaming is permitted for development, joint marketing may be limited by current laws. By denying the eventual joint use of technology, the teaming opportunity loses its merit.

In the U.S. helicopter industry, there is not a single financially successful commercial helicopter that is not a direct descendant of a military aircraft. For the more complex tiltrotor, this history reinforces business judgement that a civil program needs to be based on military experience.

Many people ask, if the potential is so good, why don't you just go ahead and build a CTR? Consider these facts. The whole helicopter industry doesn't compare in size to one modest sized aerospace company. Financially, or in any other terms, Bell Helicopter is a small company. Now, what a CTR requires is an investment by Bell (and by our partner) of $200-300 million dollars per year for several years. This is about 10 times the amount of money which is currently available to Bell for research and development. You don't bet your company on such an undertaking until market development reaches the point of confirmed orders. And to do that requires a coming together of all the system elements which have been addressed. It is noted that investments already made in the military program has weakened the financial capacity of the two partners. It is also pointed out that a total commitment to a civil tiltrotor would also dry up bread-and-butter helicopter programs for several years.

Industry, alone, cannot take all the investment risk required to realize the market potential of tiltrotor, nor can the government. If the U.S. is to create a civil tiltrotor transportation system, it needs to be started by a partnership.

PARTNERSHIP FOR A NATIONAL CIVIL TILTROTOR SYSTEM

As stated at the beginning, this is a systems issue...that of getting all the pieces to come together at one time...pieces over which no one party has authority or control. In this unique situation, a new approach is needed to overcome the barriers and realize the potential of the tiltrotor. If there were an industrial policy in the U.S., it would suggest that the public need demands that a CTR be developed on public funds. As this prospect is unlikely, our principal recommendation is that Congress enact appropriate legislation to form an enabling partnership between government and industry. These partners would have the common goal of creating a tiltrotor transportation system. They would coordinate all aspects essential to the program, many of which are beyond the control of the product developer. Membership, responsibilities and funding for such an arrangement will be complex, but a general outline is offered.

The proposed leader for the government/industry partnership is the Department of Transportation (DOT). This is recommended because this is a transportation problem, and, to appropriate funding, it should be a Cabinet level agency. The partnership would be overseen by a steering committee which for this purpose would include executive level members from DOT, FAA, NASA, and industry. For continuity, Bell-Boeing and the AHS should represent industry.

A. **CONGRESS: LEGISLATIVE PARTNER FOR CIVIL TILTROTOR**
Authorizing legislation would establish a national goal under the leadership of DOT. This would occur after the steering committee of the proposed CTR partnership had determined what actions would be most effective and had recommended legislation to the Congress.

B. **DOT: POLICY AND PROGRAM MANAGEMENT PARTNER FOR CTR**
The same legislation would authorize DOT to establish a CTR office and program management structure. This office would have the responsibility for the development of a tiltrotor transportation system. Funds appropriated to DOT would be allocated to other agencies as required. If a CTR demonstrator is to be built in future, this would be done through a government cognizant technical agency, e.g. DOD.

C. **NASA: TECHNOLOGY BASE PARTNER FOR CIVIL TILTROTOR**
In a continuation of its CTR leadership, NASA would sponsor a third phase of the civil tiltrotor technology project. As the CTR program grows, NASA would continue to evolve the technology base needed for future tiltrotor applications to civil aviation.

D. **FAA: INFRASTRUCTURE PARTNER FOR CIVIL TILTROTOR**
Funds would continue to be made available for funded infrastructure work. This includes contracted vertiport studies and in-house efforts, especially ATC. Some support will be needed for public demonstration projects.

E. INDUSTRY: DEVELOPMENT/PRODUCTION PARTNER
As the program develops, industry would perform the necessary aircraft development when the preconditions are satisfactory. Funding would be either direct or through some kind of public/private venture.

PROPOSED FY91 ACTIONS

Fund NASA for a Phase III add-on to the Phase II CTR study.
A two year risk reduction program is proposed as a continuation of Phases I and II. These studies narrowed design choices to a market defined size class. The work documented a high-density passenger market and the technical refinements necessary for a more efficient civil aircraft. The suggested logical next steps are these.

A. Preliminary design of the selected vehicle
Initial design work and analyses will identify technology issues which need to be resolved for risk reduction.

B. Wind tunnel technology confirmation
The identified technology differences between a civil aircraft and the V-22 technology base will be examined. Existing V-22 wind tunnel models will be reworked to CTR configuration. Tests would incorporate NASA and industry refinements and would provide valued steps toward CTR risk reduction for an aircraft with these technology goals.

1. Drag reduction of 50% from the V-22.
   The CTR has a streamlined pressurized fuselage less the high drag rear ramp. It has a conventional tail replacing the larger drag "H" tail of the V-22. Other refinements include a higher efficiency rotor and wing drag cleanup.

2. A 350 - 400 mile per hour cruise speed .
   A speed increase due to drag reduction and gains in rotor efficiency will be verified.

3. Environmental enhancements
   Tasks include reducing external and internal noise levels through rotor refinements and vibration elimination for passenger comfort. Pollution reduction by improved air management is also examined.

C. Planning for a CTR technology demonstrator
Based upon the design and test data, a plan will be developed and priced for building a 39 place pressurized fuselage CTR technology demonstrator.

Direct the formation of a government/industry working group

A steering committee, constituted along the suggested lines, should be established to evaluate a national tiltrotor transportation system (NTTS). As appropriate, the committee would develop a plan of action to accomplish that goal. Their agenda should include both the goals and objectives for such a system as well as the means of funding it. With "everything on the table", funding sources examined should include the Aviation Trust Fund. The principal NTTS benefit is reduction of airport congestion...the very basis for the Aviation Trust Fund in the first place. As CTR operations would return more than it would spend, this idea deserves careful analysis.

NATIONAL ECONOMIC BENEFITS FROM A CIVIL TILTROTOR PROGRAM

In addition to the stated contribution to adding capacity to national air transportation, there are some very attractive economic benefits for the United States which a CTR would generate.

A. Positive Impact on Balance of Trade

According to the FAA/NASA/DOD study, 50% of the potential CTR market is international. On that basis, the CTR export potential could be well over $10 billion dollars.

B. Impact on National Economy

There is a multiplier effect on industrial output. For the estimated CTR program this impact could amount to over $60 billion dollars added to the tax base by 2010.

C. National Employment

The creation of a new CTR transportation system adds tens of thousands of new jobs across the country. This is in addition to the multiplier effects from the manufacture of aircraft.

D. Reduction in Fixed Investment in Aviation Infrastructure

A CTR will relieve much fixed-wing runway traffic. As a result, some airport expansion or construction may be postponed or in some cases eliminated. The small infrastructure cost for CTR is dwarfed by the savings in airport infrastructure investment. There is a big spread between a $6 billion airport (serving one region) and a network of several modest cost vertiports ($11-$80 million per the FAA/NASA/DOD study). Moreover, a vertiport network would serve many communities in several regions.

E. Reduced DOD Unit Prices for V-22 Osprey

Given a CTR production program, a 10% to 15% reduction in unit production price for the DOD Osprey can be achieved. This is due to the increased production base with concurrent defense and civil production.

F. **Transportation Enhancement/Productivity Increase**
The availability of tiltrotor transportation permits the creation of new industrial/economic centers of activity remote from but linked to existing hub airports. An unmeasurable but very large level of national productivity increase will result.

G. **Retention of National Lead in Tiltrotor Technology**
Today, the U.S. has a big lead in tiltrotor technology. That lead can be maintained and economic benefits realized. Without a U.S. led CTR program, the technology will be exploited by foreign interests.

OTHER TILTROTOR AIRCRAFT CIVIL USES

A. **Health and Welfare**
Other valuable uses of tiltrotor aircraft include coastal environmental patrol, and at-sea search and rescue. Disaster relief after earthquake, flood or hurricane, as seen in recent experience, are in need of CTR capabilities. Other valued uses include drug interdiction and oil spill containment and management.

B. **Resource Development**
Exploration, development and production of distant oil resources will become possible with the advent of a long range tiltrotor.

NASA INVOLVEMENT IN THE EVOLUTION OF CIVIL TILTROTOR

In the early 50's, the Bell XV-3 tiltrotor research aircraft was contracted under NASA/Army sponsorship. Based on the promise of this technology, NASA ran a competition for a turbine powered tiltrotor. This resulted in a 1973 NASA/ARMY contract to Bell Helicopter for the development and flight test of the XV-15. Two technology development vehicles were built. Since first conversion in 1979, the two aircraft have continued to fly in a most highly successful technology test program. To date, the XV-15 has seen over 800 hours of flight time and 2400 conversions. The hands of over 170 guest pilots have flown the tiltrotor. This experience provides a high confidence level in the safety and reliability of tiltrotor technology. The XV-15 has flown to 301 knots in level flight, and 345 knots descending. It has been to an altitude of 25,000 feet (power limited). These are some of the technical/ flight qualities of a tiltrotor: ease of handling in both flight modes, ease of conversion to and from turboprop configuration, aerodynamic efficiency, passenger comfort equivalent to a modern turboprop, single engine safety, and less maintenance than a helicopter.

In 1985, NASA, together with FAA and DOD, sponsored Phase I of a civil tiltrotor study. This most extensive CTR study yet performed was to identify vehicle size, market characteristics, and technology requirements for a CTR. It was contracted to the Boeing Commercial Aircraft Company, and was completed in mid-1987. Phase I defined the desired civil market characteristics for CTR aircraft. These included aircraft size, types of operations, forecast quantities, and economics of vehicle and system operation.

Six market sectors and seven sizes of aircraft were studied. The largest single market identified was in high-density commuter passenger service. This market requires a 36-45 seat pressurized aircraft. A total of 1430 of this size aircraft were estimated as the market demand by the year 2000. Of these, 1200 were foreseen as needed for commuter passenger service.

Phase II of that study, due to be completed in summer 1990, will further define these findings. Phase II is reportedly identifying even larger requirements. According to preliminary results, this further study encourages the continuation of a CTR technology evolution and a program leading to development and production.

COMPETITIVE CHALLENGES TO U.S. TILTROTOR TECHNOLOGY LEAD

The aerospace industry, currently a bright spot in the U.S. balance of trade ($22.1 billion surplus in 1989), is threatened by strong and focused foreign competition. There is now a potential battle for tiltrotor dominance. In Europe, a combine of five companies and their governments formed a team in 1986 to develop a tiltrotor aircraft under the name of EUROFAR. Today, they are only in the study phase. With the same type of government backing given to Airbus, this fledgling effort could quickly challenge U.S. efforts and perhaps beat us to the world market. Current reduced military tensions in Europe bring a new reason for concern. The governments will now be able to transfer military R&D spending into civil projects such as EUROFAR. Maintaining the European technology level is understandably a high priority. The specter of Europe was not taken seriously in the early days of Airbus, and we are reaping the consequences. Will we forfeit the tiltrotor?

One cannot be complacent about the Japanese interest in tiltrotor to relieve their serious transportation problems. Their well publicized concept to build a network of over 3000 heliports is indicative of their thinking. What the Japanese lack in current technology, they can make up in investment and hard work. They have a demonstrated desire to copy and surpass U.S. efforts, as seen in several other fields.

We in industry and you in government face a rare opportunity. We are standing together at a time like Kitty Hawk for the tiltrotor. Do we all see the same potential? I don't see just a new product, but rather I see a new industry and a new segment of aviation transportation. I urge that we go forward together.

CONCLUSION

In conclusion, I wish to thank this committee for the opportunity to appear and present my views. I want to emphasize to this committee, as I have to other members of Congress, that the issues on which the future for tiltrotor technology should be decided are greater than just a consideration of the FY91 V-22 budget. This project, this aircraft and this technology are an unparalleled national asset of the United States. I firmly believe that there is an urgent national need for a civil tiltrotor. Such a tiltrotor system will bring value and benefit to civil aviation, not only in the U.S., but around the world. To get there, however, requires a new way of thinking. I suggest that this includes a partnership of government and industry, to review of the national benefits which a CTR system generates, and to assess methods and means to create it. And it requires continued technology funding through NASA.

July 17, 1990

Mr. Torricelli. Thank you very much.

Mr. McKeithan.

Mr. McKeithan. Sir, a number of my points in the written testimony have already been covered. I'd like, with your indulgence, to show a few slides and hit the high points of those and bring up what I think are some very important points here.

This type of vehicle—

Mr. Glickman. We'll try to get the lights lowered here for you.

Mr. McKeithan. This type of vehicle has been the dream of developers for the last several decades. Starting in the '50s, there were a number of different ways tried to try to get hover efficiency and fast vertical flight. We finally have it. Now the question is, are we going to use it?

The tiltrotor aircraft—everyone has thought of it as an aircraft that hovers like a helicopter and flies with the—like an airplane, but there's another point of this aircraft I'd like to bring up and that's that point in between. When you start moving those rotors forward from the helicopter mode and start sharing that lift on the wing and the rotor, you start bringing down the vibrations on the dynamic system of the aircraft and when you start looking at the economic viability of this aircraft, you've got to take into account the fact that the dynamic components are not undergoing all of the stresses that a normal helicopter does when it goes into forward flight. And, therefore, the cost of operating this aircraft goes down.

Now, an excellent example of this is five different demonstration tours I went on with this aircraft as the government flight rep. Over 200 hours of operation of the aircraft and not a single part in the dynamic system had to be replaced during that time on those tours. The one exception is a piece in which the pilot went outside the flight envelope of the aircraft and we had to ground the aircraft and replace that part for safety reasons. But it was not due to a wear-and-tear type of a situation.

I think you've got to look at that and when you look at cost analyses, take that into account.

Rotor technology is mature. It's based on decades of research and careful experimentation. It's at the point it is at now because we have looked at the bugs and developed the enabling technologies and brought it to the point where it is today.

The benefits are tremendous. There are just a few of them put up there. You've probably heard several of those. I'd like to amplify a little bit on the airport congestion relief. Atlanta presently has the same problem New York has. Forty-four percent of the takeoffs and landings are carrying 19 percent of the passengers. Atlanta is looking at building commuter runways to the south of the main runway in order to be able to move those small aircraft off the big runway and increase capacity. The tiltrotor can do the same thing without building those expensive runways.

The other side of that is that the cities over whom those aircraft will fly are threatening legal action and will probably tie that action up in court for years. So the tiltrotor makes a lot of sense there.

I'm not going to go into each of those areas but I'd like to go down to the bottom to the balance of trade. Japan has announced that it's going to open up over 600 heliports in Japan as part of its transportation system. There, and other parts of the Pacific Rim and in Europe, we have a trade opportunity, the ability to produce these aircraft here and sell them over there and regain part of the balance of trade we have lost over the last several years.

Research needs—I said the mature—the technology was mature. However, just like when the jet airplane went into military production, it was not the ultimate jet airplane. The V-22 is not the ultimate tiltrotor. There are technology needs that need to be looked at. The DOD, NASA, the FAA have some actions they need to take. They need to improve the various areas I've shown up on that chart.

In addition, they need to look at exploring higher speed concepts, such as folding tiltrotors, to be able to close that gap between the jet airplane and the current tiltrotor and the FAA needs to work hard and they are working hard at trying to integrate this into the airport air space system. What's being done now? Well, NASA has a basic technology program. It has the high-speed rotorcraft program. They started off a few years ago starting up a joint NASA/Navy tiltrotor technology program. However, that didn't get funded. NASA is supporting the V-22 FSD and the FAA has taken those actions.

In addition, down at the bottom, I'd like to point out that there are about 15 different metropolitan areas that are studying the ability of the tiltrotor to help their communities.

Problems. Let me talk to the second problem first, diminished R&D budgets. I just saw a couple of weeks ago, the NASA aeronautics budget for rotorcraft has remained level over the past three years, while the aeronautics budget in general has climbed several million dollars. In real terms, that is a diminished R&D growth.

The cancellation of the V-22 production, I believe, is one of the biggest mistakes ever made in aeronautics in this country. Somehow or another, we've got to turn that around because we have this in our hands right now. We've got to be able to use it. Some have said that a civil tiltrotor needs to be developed on its own merit and I believe you said that, sir.

I would like to point out that had the Federal Government not invested in hydroelectric power, in the interstate road system and other such "pork barrel" projects as those, we would not be in the technological state we're at in this country.

I don't see that government support of the tiltrotor program is a subsidy. It's an investment in the future. I'd like to also point out that the V-22 is the only military aircraft program that has a built-in peace dividend. You get a military aircraft that can do a multitude of missions and you get the technology for civil application.

Thank you very much for your attention. I'd like to answer any questions you may have.

[The prepared statement of Mr. McKeithan follows:]

Testimony of
Clifford M. McKeithan
Director of External Interactions for
The Center of Excellence for Rotary Wing Aircraft Technology
School of Aerospace Engineering
Georgia Institute of Technology
before the
Subcommittee on Transportation, Aviation, and Materials
Committee on Science, Space, and Technology
U.S. House of Representatives

Introduction

The United State's leadership in tiltrotor technology is at a crossroads. Much to the dismay of the potential users of this technology, both military and civilian, the Department of Defense leadership has erected a stop signal and does not appear to be disposed to let the light turn to green. The rationale for the DoD stand has been hotly debated and has been found to be wanting by even the most objective observers. Both the physics and the economics of the tiltrotor technology favor it over helicopter technology for medium to long range vertical lift uses. This testimony will provide some background on the development of tiltrotor technology and will attempt to clarify some of the issues that bear on the debate. It is my most fervent hope that after hearing all of the testimony given in these hearings, and examining the facts, that you will join me and a multitude of the supporters of America's technological leadership in demanding that Secretary Cheney permit production of the V-22 Osprey to proceed.

The Current Status of the Tiltrotor Program

It is important to understand why the United States has made such a considerable investment in the development of tiltrotor technology. One might be tempted to rationalize that between helicopters and airplanes, we have "all the bases covered." A closer examination of the strengths and weaknesses of each, however, reveals potential benefits that can accrue from an aircraft that possesses the strong points of both types, but eliminates their weaknesses.

I must emphasize at this point the the helicopter is a marvelous machine for uses involving short ranges (0-100nm) and long hover duration. It has proved itself over and over again as an excellent device to transport people and cargo between places that neither fixed wing aircraft nor ground transportation could effectively serve. In the military arena, the helicopter has revolutionized the conduct of combat, much as the tank did in the Second World War, allowing the commander to maneuver his forces and apply aerial fire support effectively in the face of the rapidly changing conditions encountered in modern warfare. The lives of wounded soldiers saved by the rapid response of the helicopter are a more than adequate return on the investment made in developing that technology. The helicopter has proved itself to be effective in the civil arena also, providing emergency medical service (again, saving lives daily), public service support, corporate and public short range transportation, disaster relief, remote area access, and a multitude of other uses. The major strength of helicopter is its ability to hover. It is independent of large, expensive airports, since it does not require the use of a runway for normal operations. The ability to fly low and slow permits the use of airspace not reasonably available to fixed wing aircraft. But, like any other technology, the helicopter, due to the way it operates, has limitations. The major major limitations are speed, range, limited passenger capacity, and high vibration levels (relative to an airplane).

We are all aware of the impact of the airplane on our world. From its earliest days, it was readily recognized for the potential it held. All of the major nations in the world made a considerable investment in nurturing and developing the airplane, both in refining and evolving the technology in the aircraft itself and in investing in the infrastructure to effectively use its capabilities. Until the advent of the space age, nothing has captured the imagination of man like the airplane. For many, flight has taken on the dimensions of a religion. Today, we see the results of of the many years and billions of dollars we have invested in the airplane. We take a transcontinental airplane trip as readily as we would have undertaken a 100 mile automobile trip twenty five years ago. The speed, comfort, and relative economy of civil jet airplane transportation make it the preferred mode for a major segment of the population. However, the civil jet airplane was not without its detractors and nay-sayers. When Boeing was developing the 707, economic analyses showed that the jet transport could not compete with its piston-driven counterpart. It required vision and belief in the future to make a bold technological step, but Boeing, Douglas, Convair, and DeHavilland (in England) and the airline companies made that step. The air transportation revolution resulted. On the ground side, billions and billions of dollars were invested by the Federal, state, and municipal governments in an infrastructure to support civil jet transportation. The economic and social benefits were recognized by all. Every major community either built major jetports or converted former military training bases into civil airports. The impact of this air transportation explosion on these communities accelerated the economic growth of these communities and today is an integral part of their economic health. The airplane proved itself to be a safe, efficient mode of transportation. Today's airplanes are fast, comfortable, have high passenger capacity, and have extensive range capability. But, like the helicopter, the airplane has its limitations. The most significant is its dependence on runways. The size and landing speed of todays jet transports require the use of long runways (typically over 10,000 feet long). To meet the demands of today's transportation system, most airports have multiple parallel runways, resulting in the demand for enormous tracts of land. In today's real estate market, that land is costly to the point of being almost unaffordable. The requirement for runways has another detrimental effect. The dependence on runway use channels arriving air traffic into long, congested lines of aircraft waiting to land, and departing traffic into long lines on the taxiways, burning fuel while waiting for an opportunity to depart. This results in a tremendous waste of time and money and a congested air traffic structure. A major impact of the runway requirement is on airport capacity. The most significant factor affecting airport capacity is the number of airplanes that can be accommodated by the runway system. When the runways reach capacity, the airport reaches capacity. The other major limitation of jet airplanes is external noise. Little opposition to the development of airports occurred in the 1960's and early 1970's. It was not until the unwise proliferation of housing developments in the flight paths of airports that the backlash against airport noise became a serious issue. In the last three years, I have attended several symposia on airport noise control. There are few special interest groups in this country who are more passionate or vocal that than those opposing airport noise. It is of no consequence in the minds of these groups that the airport existed before the housing developments. What is of importance to them is that the quality of their lives is diminished by the noise. Whether right or wrong, the noise emitted by aircraft has brought about severe limitations in the ability of communities to build new airports or expand existing facilities and it has caused the imposition of noise abatement procedures for the operation of aircraft. Some of these noise abatement procedures cause the aircraft to be operated to the very margins of their aerodynamic capabilities and leave little room for error or safe recovery from equipment malfunction. Thus safety becomes compromised for the sake of noise abatement.

Since the advent of the airplane in the first part of this century and the advent of the helicopter in the 1940's, man has recognized that both had limitations and has pursued ingenious ways to overcome their limitations. After the advent of powered fixed wing flight, Juan de La Cierva and Igor Sikorsky began working on ways to overcome the low speed limitations of the airplane. La Cierva developed the autogiro and Sikorsky (and various European engineers) worked at developing a practical helicopter. The autogiro was reasonably successful at lowering the stall boundary of the airplane and lessening the room required to take off and land, but it could not hover. The helicopter could hover, eliminating the need for runways, and its development was spurred on by emerging military requirements. The helicopter's limitations were also recognized and extensive research and development has resulted in major improvements in range, speed, efficiency, capacity, and ride quality. However, as stated above, these limitations still exist to a significant degree. Engineers have long sought to combine the capabilities of helicopters and airplanes into a single vehicle. Over the last several decades, dozens of candidate concepts have been explored: tiltwings, deflected thrust, tilting ducted fans, vectored jet thrust, compound helicopters, retracting rotor compounds, stopped rotor aircraft, and a plethora of other ingenious ideas. Each of these concepts had its shortcomings and often fatal flaws, usually because the basic enabling technologies were not sufficiently mature when the concept was explored. These vehicles were then relegated to museums and, often, scrap piles, and were branded failures. One technology, the tiltrotor, kept re-emerging over several decades as having sufficient potential to make the airplane-helicopter marriage work that engineers revisited it with each major advance in enabling technologies. Each time, tiltrotor concept matured a bit more.

The tiltrotor concept is not a new one. The first recorded conceptual design was for the British Baynes Vertiplane in 1937. This was a visionary design and incorporated several unique features for that period, such as turbine engines. This design did not progress past the conceptual stage, however and the tiltrotor concept remained dormant until World War II. The Germans developed the Focke-Achgelis Fa-269, a unique design that featured rotors that converted from a downward position under the wings to a rearward position where they acted as thrusting propellors. Prototypes were reported to have been built, but were destroyed in an Allied Forces bombing raid. In 1946, in the United States,W. Laurence LePage suggested a tiltrotor design based on his XR-1 helicopter, but the technology was not in place to build it. The next occurrence of the tiltrotor was the Transcendental Model 1-G in 1954. This aircraft was the first tiltrotor design known to fly, but due to technical difficulties, did not achieve conversion to airplane mode. The Transcendental Model 2 made research in their bid against Bell for the XV-15 development). Sikorsky Aircraft declined to bid, even though that company had done previous research and conceptual designs of tiltrotor aircraft. Of particular note was a standing offer by NASA to help any U.S. aircraft manufacturer "come up to speed" on tiltrotor technology. Since the U.S. Government has funded the majority of the tiltrotor research, most of the technical information is public domain. Sikorsky declined the offer. Despite several "glitches" such as the transfer of program management responsibility from the Army to the Navy, the withdrawal of Army requirements and participation from the program, and the unprecedented requirement that the developers absorb some $300 million in tooling costs, the development of the JVX , now named the V-22 Osprey, has progressed remarkably well, especially when compared to the development progress of most major aircraft programs. The first V-22 flew on March 19, 1989 and has been joined in flight by numbers 2, 3, and 4 of the planned six prototype development. The aircraft has performed very much as predicted and the testing is proceeding at a reasonable pace. I know of no technical reason why the V-22 should not be able to enter production.

What about civil interest in tiltrotor technology? Back during the early 1980's as we were doing the military mission testing using the XV-15, everyone involved with the program was aware that tiltrotor technology held the promise of benefiting not only the military services, but held a more far reaching potential for the civil sector. As the studies for the JVX came to a close and that aircraft began its development, manpower and resources were brought to bear on definition of the civil benefits of tiltrotors. These efforts were spearheaded by Dr. John Zuk, the Chief of the Civil Technology Office at the NASA Ames Research Center. As early as 1983, Dr. Zuk was exploring the potential benefits of a civil version of the JVX. At the same time, the FAA sponsored a National Rotorcraft Program, seeking to identify improvements in the national interurban transportation networks and identified tiltrotors as having high potential to provide such improvements. The DoD, the FAA, and NASA joined in a study in early 1986 "to assess the broader implications of the V-22 aircraft development to the nation as a whole. This includes the potential for other versions and sizes, both civil and military, civil certification issues, civil production impact on the defense industrial base and any indirect technology spinoffs. . ." Dr. Zuk was the Study Director and I had the pleasure of serving as the Study Manager. The team selected to perform the study consisted of Bell Helicopter, Boeing Vertol, and the Boeing Commercial Airplane Company. The latter was selected for several important reasons. First was their vast world-wide market study experience and their proven methodologies. Second was the considerable database they possessed. Of equal importance was the fact that BCAC was not a helicopter manufacturer. At the beginning of the study, the BCAC participants were almost all skeptics regarding the commercial potential of the tiltrotor. It was interesting to see that skepticism evolve to enthusiasm as they learned what tiltrotors were all about. As the study progressed, the emerging results confirmed what we early supporters knew - that there were definable benefits and considerable markets for civil tiltrotor aircraft.

As the FAA/NASA/DoD Civil Tiltrotor Study began to take shape, Dr. Zuk and I met with officials of the Port Authority of New York and New Jersey and local FAA officials to discuss the potential for tiltrotor technology to help alleviate the mounting airport capacity problems in that region. After several meetings, and having been exposed to the performance of the XV-15 technology demonstrator, the Port Authority commissioned a study of the potential impact of VTOL technology on the intercity air transportation system surrounding the New York area.

A key player in the civil tilt rotor technology arena is the FAA. Even before the start of the FAA/NASA/DOD study, the FAA had been monitoring the progress of the tiltrotor development and foresaw the very real potential for civil variants to be placed into service. With this in mind, the Southwest Region of the FAA began to consider the certification requirements for aircraft like the tiltrotor, such as the tilt wing, the lift fan, and vectored thrust aircraft. The result was a draft interim airworthiness criteria document for powered-lift transport category aircraft This document was released for comment, and is under revision. In June, 1988, the then Administrator of the FAA, T. Alan McArtor, announced that the FAA would be ready to approve provisional certification of a civil version of the V-22 for flight demonstrations. He directed the FAA to negotiate an agreement with the DoD permitting the FAA to have access to V-22 test and engineering data. Early access to such data and possible participation in the testing will serve to accelerate the civil certification of tiltrotor aircraft. He also directed the FAA to accelerate its internal efforts to be better able to accommodate the entry of tiltrotor aircraft into civil use. These efforts include airspace review, finalizing certification standards, development of flight test criteria, and development of training and certification standards for tiltrotor pilots. The FAA also stepped up its schedule for the planning and development of vertiports, including terminal procedures and technical design and construction standards. At the present time the FAA is funding tiltrotor application studies in 15 cities using some $2.7 million of AIP funds. These studies will provide the FAA solid information on transportation requirements and the role that tiltrotor aircraft can play in meeting those requirements.

Considering all of the interest and activity in the civil arena concerning tiltrotors, one can only conclude that the civil sector is seriously considering ways to apply this technology, but like the introduction of the jet transport in the 1960's, success will depend upon the military program to gain the confidence required.

Benefits of a Civil Tiltrotor System

Airport Congestion.

Over the past twenty years, demand for air transportation services has outpaced the construction of new facilities. The result is that in the majority of our major cities, the airports are reaching capacity both in the number of gates available and runway capacity. As the cost of air transportation became more affordable, and disposable income for large segments of the population increased, travellers switched from buses and trains to enjoy the shorter transit time and increased time available at their destinations. The resulting demand for air transportation services is driving the country into a genuine transportation crisis.

Delays at airports are blamed on a number of factors, the most frequently cited including weather, overscheduling, and air traffic control problems. There is a growing consensus, however, that the problem is one of capacity. The major airports are scheduling more operations than can be handled in good weather and the occurrence of bad weather almost always seriously overloads the system.

Some of the studies currently being conducted have revealed some intriguing facts regarding airport capacity. As an example, consider the data presented in Table 1.

Cities	PerCent of Arrivals from less than 300 Miles
ATL	32
BOS	74
DEN	15
DFW	28
JFK	50
LAX	40
LGA	48
MIA	28
ORD	42
SFO	53

Table 1. Short Range Arrivals at the Ten Busiest U.S. Airports
(Source: August 1989 0AG)

On the average, some 41% of the arrivals originate less than 300 miles away, the approximate 1-hour radius of the tiltrotor. Over half of these aircraft are small commuter airplanes with a capacity of for 19 - 24 passengers. If only a half of the "regional" traffic could be diverted to on-airport or urban vertiports, and the arrival spaces filled with larger aircraft, the arrival runway capacity could be increased approximately 29% with the same number of landing operations. Departure statistics are similar. At the three major New York airports, 50% of the departures carry 82% of the passengers greater than 300 miles. 44% of the departures carry 18% of the passengers less than 300 miles. By diverting one-half of the "regional" departures to vertiports, an increase of 23% in departure capacity could be realized.

It might be argued that the way to cope with the increased demand would be the construction of new airports. However, due to the cost of acquiring large tracts of land in major population areas, and the opposition to such construction due to noise and environmental concerns, the chances of success are low. The cost of construction of a major airport today has been estimated to be in the range of 3 - 4 billion dollars, not including the cost of the aircraft serving the facility. By contrast, a system of vertiports to absorb the increase in demand, including the acquisition cost of the tiltrotor aircraft to serve them, would be about half that much. It is clear that the vertiport option is attractive in today's climate.

A most important point needs to be made at this juncture. All of the studies that have been conducted correctly find that tiltrotor aircraft cannot economically compete with turboprop airplanes when operating between fixed wing airports. That comparison is made with the assumption that the airports in question are not at capacity and can handle the increased traffic. However, when capacity is reached, no more fixed wing aircraft can be accommodated and VTOL aircraft, operating from vertiports located on the airport or in the urban area, provide the only viable method of meeting the demand. At the point when capacity is reached, conventional economic comparisons are no longer valid, and what was once not affordable becomes affordable.

City-Center and Population Center Regional Air Transportation Systems.

In the last few decades, the growth patterns of our major cities have lead to an interesting demographic phenomenon. As airports and cities expand, the regions around the airports tend to become commercial (light industry and warehouse) zones. The majority of the people who use air travel tend to live in housing developments far away from the airport, often on the opposite side of the city. The airports tend to be located some 15 to 45 miles from the heart of the business district. Thus, the majority of the traveling public, both for business and personal reasons, must travel long distances on the ground through congested areas to reach the airport.

An excellent example of the business traveller's problem is that of the New York traveller. From downtown Manhattan, the traveller can expect to spend approximately 35 - 50 dollars and 45 minutes for a cab ride to LaGuardia airport. Since most of the business travel from our major cities is of lengths of less than 300 miles, the traveller spends more time in ground transit that in the air. Over a period of time, this adds up to tremendous amounts of non-productive time. This cost to businesses has been recognized as significant by a number of businesses who will use helicopter transportation to recover some of this lost time for high value executives. For the greater majority of business travellers, however, this has not been an affordable option, and they must live with the loss of productive time. The limited range and speed of the helicopter has limited its potential for city-center to city-center transportation. Also the vibration and noise levels of helicopter, though much improved over previous machines, limit passenger comfort levels to periods less than two hours.

Likewise, the recreational traveller, or the business traveller who begins or terminates a trip at his home, must endure a long ground transportation leg, often through bumper-to-bumper traffic to enter the air transportation system. Few cities have implemented a truly efficient light rail service to move people from population centers to the airports. Even the modern MARTA system in Atlanta, although it serves the area inside the perimeter highway very well, does not extend into the population centers to the north of the city. This area houses the majority of the air travellers, and they must depend on auto or bus transportation as a link to the airport.

The advent of the tiltrotor provides the potential for the implementation of safe, economical, and efficient intercity transport. The tiltrotor aircraft with its low noise profile, high speed, low vibration levels, and economy of operation, can make regional air transport from urban centers a reality. Operating from vertiports established on the rooftops of buildings or over freeways, the tiltrotor can provide the business traveller rapid transport, after a short walk or cab ride from his office, to a location in his destination city a short cab ride from his appointment. In many major cities, the financial district is a short distance from a lake or a river (recall that water transportation formed the basis for the early development of this country) or from a railhead. These areas are ideal locations for the construction of a vertiport and would afford business travellers easy access. Examining the major population areas around a typical city, it can be noted that a large freeway network exists, often forming a ring around the city and having a series of "spokes" projecting into the major housing areas. A system of vertiports could be constructed over the freeways at strategic locations to permit regional travellers to begin or terminate trips at a location close to home. Such a system could be designed to permit those wishing to board long-range airplanes to take an air or rail shuttle service to the major airport to make connections. The vertiports could be co-located with light rail facilities, making multimodal facilities, long a dream of transportation planners, a reality. The question of regional air transportation has been studied in depth by the Port Authority of New York and New Jersey and to some extent by the FAA/NASA/DoD Civil Tilt Rotor Study. I refer you those those studies for more detailed data and conclusions.

The nation's first downtown vertiport is already under construction. It will be a part of the Dallas Convention Center and should be completed before 1996. The vertiport will cost from 10 to 12 million dollars and in its Phase I configuration will provide for parking spaces for four V-22 sized tiltrotors and 12 helicopters. Two landing pads will be provided and can be used as a "rollway" to permit tiltrotor and tiltwing aircraft to conduct STOL operations, thereby increasing their range or operating weights. The facility will provide a realistic and workable solution to the intercity transportation problem.

Noise Abatement.

Airplane noise is probably one of the most serious impediments to expansion of our air transportation system. Indeed, the noise problem is so severe that some airports are struggling to remain in existence. Airports have had to expend billions of dollars in federal aid to purchase noise-impacted land around the airport and to convert this land from housing to light industrial use. Noise abatement procedures have been imposed upon aircraft, often forcing those aircraft to be operated near their aerodynamic limits, causing an attendant compromise in safety of operations. An example of how noise problems can limit an airport's ability to increase its capacity is Atlanta's Hartsfield International Airport. Last year, the airport released a plan to expand capacity by building a complex of commuter runways to the south of the existing runways, thus allowing the main runway capacity and that of the airport, to be increased. As soon as the plan was released, communities over which the commuter aircraft traffic patterns would lie began to protest the plan and vowed a vigorous legal battle to prevent the construction.

Tiltrotor aircraft have an intrinsic quality that make them less noisy than similar airplanes or helicopters. In the helicopter mode, the large degree of blade twist lowers the sound level emitted and gives it a character that is unlike that of a helicopter's emissions. Observers have stated that the sound is less objectionable than that of a helicopter. When the tiltrotor converts to the airplane mode, its rotors act like large propellors, turning at approximately 600 rpm, as compared to a turboprop, whose propellors turn at 1900 to 2100 rpm. The noise level emitted by the tiltrotor is so low, it is barely discernable as it passes 500 feet to the side. A comparison of the tiltrotor's noise to fixed wing, helicopters, and FAA requirements is shown in Table 2.

	Location	FAA Rule	Tiltrotor Estimate	BV-234 Actual	DHC-8-102 Actual
(Fixed Wing)					
FAR 36	Takeoff	89.0	60.0	-	80.8
Stage 3	Sideline	94.0	74.0	-	86.3
(EPNdB)	Approach	98.0	77.0	-	94.8
(Rotary Wing)					
FNPRM	Takeoff	101.6	78.0	96.2	-
14CFR	Sideline	102.6	84.0	97.2	-
(EPNdB)	Approach	103.6	77.0	102.1	-

Table 2. Noise Level Comparison of Tiltrotors, Helicopters, and Fixed Wing Aircraft

Note that the projected noise levels of tiltrotor aircraft are well within those permitted by current federal rules. In fact, the noise generated by the tiltrotor will remain within the confines of the vertiport. During hover operations prior to takeoff, the 80 dBA contour extends only 183 feet from the center of the takeoff pad and during acceleration and conversion extends only 418 feet along the takeoff path. On approach to landing, the 80 dBA level extends only 226 feet from touchdown. In considering urban vertiports, the noise produced by the tiltrotor will not create an impact on the surrounding community. For those vertiports built over freeways, the noise generated by the tiltrotor is less than the average noise generated by road traffic. At airport locations, the tiltrotor is converted to airplane mode before it passes the airport boundaries and is virtually inaudible. For example, at demonstrations of the XV-15 at the Monterey, CA airport, the noise measuring equipment at the airport could not detect the aircraft's operation. Thus, the noise levels generated by the tiltrotor give it the promise of being a good neighbor, and the ability to provide air transportation facilities close to the urban population without the noise impact generated by other types of aircraft.

Airspace Utilization.

A major concern when any additional air transport service is postulated is whether the air traffic control system can accommodate the increased load. From the standpoint of manpower, it is a certainty that unless major improvements in automation are realized, any increase in air traffic will require an increase in manpower. What is unique about the tiltrotor is its ability to use airspace that is presently underutilized. Due to the limitations of fixed wing aircraft, and the capacity of runways at the airports, as aircraft approach for landing or transition upon departure for enroute airways, they are channeled into a zone extending for miles from both ends of the runway axis. This zone is characterized by a high density of aircraft, with each aircraft having to carefully regulate its airspeed to ensure spacing from other aircraft. However, this high density zone comprises only about 30% of the useable airspace around the airport. This underused airspace provides a ready conduit for tiltrotor traffic. Unhindered by the need to use fixed runways, the tiltrotor aircraft can make Microwave Landing System (MLS) approaches and departures without the constraints experienced by conventional airplanes. Since the approaches and departures can be at right angles to conventional traffic, these operations can be conducted simultaneously, with minimal interference with runway operations.

An often unrecognized attribute of the tiltrotor is its ability to operate at any speed between hover and its dash speed limit. This provides air traffic control a powerful tool in fitting tiltrotor aircraft into the traffic flow. Often, controllers are hampered by the inability of a large aircraft to fly slower or a small aircraft to fly faster to facilitate adequate separation. A tiltrotor can provide the controller the desired speed upon demand and do that without any compromise to its safe operation.

The enroute airways are also tailored to high-speed, high altitude fixed wing operations. Examining maps of the airways system, one is struck by the fact that some airspace is characterized by high aircraft density, while close by, there is airspace that is sparsely populated. This is, in large part, due to the need to route aircraft for eventual transition into the airport traffic areas, tending to force enroute traffic into high density zones. Tiltrotor aircraft do not need to be constrained by the needs of airplanes. The use of medium altitudes along the Victor airways and the use of "direct routing" or the establishment of special VTOL routes can more effectively use the available airspace while avoiding conflicts. I should note that the FAA is actively studying the airspace and terminal area aspects of VTOL aircraft to prepare for their eventual integration into the airspace system.

Package Express.

I cannot think of an activity better suited for tiltrotor aircraft than package express. Package express service is one of the most rapidly growing industries in the United States, and perhaps the world. Who among us have not had the occasion to use this service when there was an urgent need to have something in another's hands as quickly as possible? The upward trend in the use of this type of service is likely to continue, but in the large urban areas, package express is beginning to experience some difficulty in getting packages from the pickup points to the airports. The key to successful package express service lies in the ability to pick up the packages, take them to an airport, fly them to a central sorting facility, sort and transport them to the destination city, and deliver to the consignee. All of this must be doable overnight, on a consistent basis. Delays in any part of the chain of events makes the system break down, and delays are becoming a real problem on the ground pickup and delivery links of the chain. Gridlock is becoming more commonplace on the freeways in our major cities. Often, I have sat in traffic with a Federal Express, DHL, or UPS truck sitting next to me in a sea of stalled vehicles. More often than not, it was evident that those packages would not make it to their destinations by the next morning.

The tiltrotor aircraft, in a plain "vanilla" version of the V-22, could be used in the package express industry as soon as production begins. The size of the cargo compartment of the V-22 is such that it can accommodate three LD-3 cargo containers without modification. (Variants of the V-22 could accommodate six LD-3s.) Lack of pressurization is of no major consequence since lack of oxygen rarely damages packages. The package express tiltrotor could operate from a series of vertiports, or vertistops located in business, industrial, or urban areas. Ground vehicles could pool packages at these facilities, where some presorting for closer high-density markets could take place. Tiltrotors would pick up the containers, fly to the airport package express facility, drop off containers of packages that need to go to major sorting facilities, load containers of presorted packages, and deliver them to destinations within 600-800 miles. Thus for city pairs that have a high package traffic demand, the trip to a central sorting facility would be eliminated. With the availability of the aircraft, and the availability of vertiports and vertistops, the burgeoning ground traffic problem need not be a roadblock to the package express industry.

An executive of Federal Express stated at a recent conference, "The V-22 offers the ability to expand and improve service, compress time." In the same speech, he added the caveat, "...its ... mechanical dispatch reliability is very uncertain, particularly without the military "pathfinders"." That statement typifies the attitude of most users of technology. Few are in the business of developing technology for their own use. They prefer, and in an era of low profit margins, are constrained to use proven, reliable technology. Most depend, at least in the aviation arena, for the military services to be the "pathfinders", the provers of the technology. This has been historically the case, even in the case of the jet transport. Only after several years of military experience, proving the reliability of the jet engine, and the development of a transport-like aircraft, the KC-135, did U.S. manufacturers commit to developing civil jet airliners. It is not surprising, therefore that the potential users of tiltrotor technology desire to see the V-22 proceed and provide the confidence level necessary for commercial application.

Commuter Airlines

The commuter airline industry largely services the short-haul business market and provides feeder service for the long-haul airlines. These airlines use mostly foreign manufactured airplanes and operate in the low altitude portions of the airway system. As stated in the above discussion of airport congestion, the commuter airplanes are constrained by the same limitation possessed by long range transports: they are required to use a runway. Success in the commuter market, especially in the feeder portion, depends upon the ability to make tight schedules. When a commuter aircraft is forced to line up miles away from the airport in the queue of aircraft waiting to use the runway, it becomes difficult to maintain the published schedule, and passengers often miss their connections. If the commuter airlines were able to operate tiltrotor aircraft, they could make their approaches and departures independent of the majority of the airport traffic, allowing them to operate more efficiently.

Another factor affecting commuter air service is the availability of ground facilities. This country had a highly beneficial aviation fallout after World War II. During the war, thousands of air training facilities and outlying practice fields were constructed. After the war, control of these facilities were passed to the civil authorities. Many were converted into civil aviation facilities, while others found industrial or educational uses. While many communities had the benefit of air transportation service, population growth patterns have produced a large number of communities for whom air transportation is not reasonably available. In many high population density areas, a traveller must make a two hour journey to board an aircraft. High costs and noise concerns prevent the establishment of commuter air facilities in these localities. The advent of the tiltrotor aircraft and its ability to operate from low-cost vertiports, makes it possible to tap commuter markets that were not previously accessible.

Economic Development of Rural Areas

Many states have large rural areas in which they wish to promote industrial development. Low cost work forces exist, but industry does not.

Developers are hesitant to propose industrial developments in areas without air transportation readily available. Industrial development, in addition to a work force and in some cases, raw materials, needs a substantial road or rail network for the movement of goods and supplies and an air transportation system for the travel by managers and the sales force. The tiltrotor aircraft makes it possible to provide the air transportation system at a fraction of the cost required for an airplane-based system.

Corporate/Business Travel

The majority of Fortune 500 companies operate aircraft for the transportation of their executives and high value customers. Many operate jet aircraft and helicopters, and some have such extensive air fleets that they have a vice president in charge of air operations. Tilt rotor aircraft could provide many of these companies the capability of improving the service and efficiency of their air operations. A typical scenario shows a corporate executive making a trip to visit one of the company's manufacturing plants. A company helicopter picks him up at corporate headquarters and flies him to the regional airport. There he boards the company jet and flies a few hundred miles to an airport near the plant. Another helicopter takes him to the plant for his meeting. In this situation, which is quite common, the company uses three aircraft and three crews to accomplish a single task. With a corporate tiltrotor, a single crew and a single aircraft could transport the executive directly from headquarters to the plant. What speed advantage the jet possessed was lost by the time required to fly by helicopter on both ends of the journey and to change modes. The tiltrotor offers corporate users speed, comfort, flexibility, and the ability to operate a single kind of aircraft.

Support of the National Aerospace Plane (NAS)

Our nation is engaged in the development of a hypersonic aircraft that promises to provide rapid transcontinental and transoceanic transportation. This is especially attractive with the economic development opportunities emerging in the Pacific Rim. Effective interaction with the Pacific Rim countries can be greatly enhanced by the National Aerospace Plane. Along with the tremendous promise, however, there come technical difficulties which are not readily apparent. The technical problems associated with the aircraft itself, such as high temperature materials and exotic fuels, are being attacked vigorously by NASA and the aerospace industry. These problems are likely to be solved and the aircraft should function as predicted. The problem that is not so readily apparent and, to my knowledge, is not being seriously addressed, is that of the location of airports that will serve as operating bases for the NAS. Among the problems that bear on the operating bases for the NAS are the fact that it will maintain supersonic flight in close proximity to its point of departure or arrival and the high probability that it will use exotic, potentially explosive fuels. These two factors are sufficient (given that noise and environmental concerns will continue) to conclude that it is unlikely that the NAS will operate from facilities such as Los Angeles International, Dulles International, or Kennedy International airports. Instead, the NAS will operate from remote areas such as Palmdale, CA or Stewart, NY, or even from facilities built offshore (Japan already has plans to construct such an offshore airport). In any case, there will not be an easy, economical way for the transfer of passengers from the major metropolitan areas or from the regional airports to and from the NAS facilities. While fixed wing transportation might do the job, remember that capacity problems at the regional airport will be a problem. Commuter airlines, operating tiltrotor aircraft appears to be a viable solution to the problem.

Off shore Oil Support

The off-shore oil industry has a unique problem. The workers on the oil rigs are paid premium wages from the time they board transportation to the rigs until they return to shore. With rigs moving further and further offshore in the quest for new oil supplies, the cost of transporting workers becomes a major economic factor. The oil companies presently use helicopters for this task, but the further the rigs are from shore, the more taxed are the capabilities of the helicopters. At the further ranges, the helicopter becomes economically infeasible. Until now, no viable alternative existed. However, with twice the speed and twice the range of the helicopter, the tiltrotor can provide a reasonable means of transporting these workers, minimizing the amount of premium wages that must be paid for non-productive transport time.

Resource Development

Remote areas of the United States, such as Alaska, possess untold quantities of precious resources that cannot be developed or exploited due to the lack of a viable transportation system. Due to the rugged nature of the terrain, and the engineering problems presented to the construction of roads by the permafrost, Alaska must depend upon air transportation for functions that normally are met by roads in more hospitable terrain. Newcomers to the state are amazed to find that small general aviation aircraft are used to transport a major portion of the fish harvest to canneries and shipping facilities. Remote villages in the state are totally dependent upon air transportation for contact with the outside world.

The same obstacles to roadway development in the state also affect the construction of airport facilities. In one instance, a sixteen foot extension of a runway cost approximately $40 million. The cost of construction of a runway to accommodate Boeing 727/737 class aircraft is astronomical. Even when that investment is made, during the winter months, the cost of operation of the facilities is escalated by the need to remove ice and snow. Approximately seventy-five percent of an airport's operating costs are expended for this function.

The tiltrotor offers an air transport option that can significantly lower the cost of providing air transportation facilities. While it is true that a tiltrotor cannot be operated as economically as a fixed wing aircraft from facilities with adequate runways, if the cost of keeping the runways clear is factored in, the higher acquisition and operating costs of the tiltrotor are balanced out, and indeed, the tiltrotor can be the cheaper option. In areas that need to be developed, the lower cost of construction of a vertiport over an airport, can easily offset the cost differential of acquiring and operating the aircraft. The additional flexibility offered by the tiltrotor means that service can be offered to many remote areas with only minimal construction.

The same reasoning can be applied to remote desert regions or heavily forested areas. The cost of vertiport construction and tiltrotor acquisition is much more affordable than the construction of adequate roads and airports. For example, in the exploratory development of mineral resources in a remote desert area, crews and equipment can be brought in and supplied while determining the viability of a resource development venture. Only after a high probability of success is determined would the heavy investment in roadways to sustain the expansion and operation of the facility be necessary. Had the venture not been successful and had roadways already been built, the sunk investment in the roads would have been lost.

Drug Enforcement

The interdiction of the flow of illegal drugs into the United States is a monumental task. In addition to all of the watercraft that the DEA, the Coast Guard, and the other military services devote to this mission, a number of aircraft of diverse types are used. A typical air mission consists of three phases: detection, surveillance and tracking, and interception and arrest. Generally, a long range, long endurance airplane such as a Falcon or a P-3 with radar is used for the detection phase. Once a suspected airborne smuggling operation is detected, a high speed turboprop or jet airplane is vectored by the radar aircraft to intercept and follow the smuggler. When the smuggler lands, trucks are often driven onto the runway to prevent the chase aircraft from landing. It is therefore necessary, as soon as a landing location(s) is postulated, to vector helicopters bearing DEA agents to the site to capture and arrest the smugglers and confiscate the illegal drugs. In this scenario, a minimum of three and often more aircraft are used to complete the operation. The use of a tiltrotor aircraft for this mission has the obvious advantage of using a single aircraft for the entire three phases. The tiltrotor can mount the necessary radar for detection, it has the speed to intercept and follow most aircraft, and it can land without a runway to deliver the DEA agents. The tiltrotor can be a powerful tool in the fight against illegal drugs.

Search and Rescue

Many lives are saved each year by the Coast Guard and military search and rescue units. Currently, a typical SAR operation is conducted using several aircraft. Upon notification that a SAR operation is required, the unit dispatches a turboprop or jet high-speed aircraft to conduct the initial search. Time is critical in order to save lives. The airplane proceeds to the search area and begins a wide search pattern to locate the ship or aircraft in distress and survivors. While the airplane is enroute, a helicopter will be dispatched along with a fixed wing refueling aircraft. Upon arrival at the scene, the helicopter recovers the survivors, refuels as necessary and proceeds directly to the nearest medical facility. This mission is another in which a tilt rotor aircraft can replace two different types of aircraft. A single tilt rotor has the speed and range to perform the rapid, long range search and the hover capability to pick up survivors and deliver them to a hospital helipad or a ship's medical facility.

Disaster Relief

One of the recurring problems of natural disasters is the blockage or destruction of road networks. In recent years, the eruption of a volcano in Columbia, the earthquake in Mexico City, and the horrendous destruction wreaked by Hurricane Hugo on Charleston, SC have provided vivid examples of Nature's awesome power to destroy facilities, road networks, and communications facilities. In Columbia, melted snowpacks triggered mudslides that buried entire villages and made airports unusable. Helicopters were the only vehicles capable of traversing the countryside, rescuing survivors and delivering life-saving supplies and medical attention. The Mexico City earthquake likewise buried roads, and streets and made airplane access difficult. Again, the first life saving efforts were made through the use of helicopters. When Hurricane Hugo hit, the widespread destruction was reminiscent of massive bombing strikes. Forests were felled, towns blown away, power systems were destroyed, and people were isolated. While help came, it came slowly and there is much debate about its effectiveness.

We have the technology available to provide a disaster relief organization with unprecedented capabilities to rapidly react to disasters at home, in the western hemisphere and even the rest of the world. Whether managed by FEMA or some other agency, we can put together a pool of supplies and disaster relief technicians that can rapidly deploy to provide immediate medical attention, search and rescue, initial power and communications, and food and water facilities. Tiltrotor aircraft can deploy such an disaster relief team anywhere, using aerial refueling as necessary, without regard to airport facilities. Their airplane-like cruise speed will permit them to arrive on the disaster scene quickly, during the period when rapid attention can save lives. Once an operating base is set up, the tiltrotors can ferry additional supplies into the disaster area from operating airports, transport damage assessment teams, and evacuate the injured to more suitable facilities.

Emergency Medical Services

The helicopter has gained a great deal of respect in the civilian community because of the number of lives that have been saved with their quick reaction time and independence of prepared landing facilities. Tiltrotor aircraft can extend the range of EMS services to twice that of the helicopter in the same flight time, thus affording those services to a greater segment of the population. In the case of inter-hospital transportation of patients, tiltrotors can pick up patients at hospital helipads, transport them long distances at high speeds, and deliver them direct to medical facilities at the destination.

Border Patrol

The United States enjoys good political relationships with its neighbors to the north and to the south. The borders with Canada and Mexico, however, present large expanses that are difficult to adequately patrol. Those who engage in the transport of illegal immigrants and drugs find our borders to be relatively easy to cross. Part of the solution is an adequate border patrol force. Another part of the solution is equipment suited to the task: radars, night vision devices, and aircraft that permit the border patrol to detect and apprehend border crossers. The tiltrotor is ideally suited to this task because it possesses good speed characteristics, is able to transport enforcement teams, and can land wherever necessary, without undue regard to terrain conditions.

Oil Spill Containment

Last year, the worst man-made environmental disaster in memory took place. The Exxon Valdez oil spill did incalculable damage to the Alaskan shoreline and raised the environmental consciousness of the world. Although proposals for improved oil tanker hulls have been made, the oil industry will not implement those improvements until forced by Congress and other world legislative bodies. For the present, it is business as usual.

Thus, we may well expect other oil spills to occur. Marine oil spills are similar to natural disasters - the effects can be minimized if we react promptly to contain the disaster. In the case of oil spills, tiltrotor aircraft under the control of the Coast Guard and the military services can deploy from their home bases to prepositioned stocks of supplies and equipment. That equipment can be quickly moved to the location of a spill, a matter of hours (currently, these assets are moved by boat, consuming precious days in the process), and upon arrival, can begin deploying oil containment booms around the spill. Other tiltrotor aircraft can be configured with holding tanks so that the process of skimming the oil from the water can begin. This will buy precious time for shipborne skimming equipment to arrive and finish the job. Some might decry the expense of this manner of dealing with spills, but when one considers the cost of the Exxon Valdez cleanup (which has not been satisfactorily completed), well over two billion dollars, a multi-million dollar investment in such a system to deal with these disasters will be easily recoverable.

Development of Caribbean Basin

One of the United States' stated priorities is assistance in the economic development of the islands in the Caribbean Basin. This region is important to the United States politically and it is in our interest to foster its economic development and well-being. The U.S. Department of Commerce has a Caribbean initiative program that provides incentives to stimulate investment in ventures in that region. One of the impediments to economic growth is the lack of an effective air transportation system to all of the populated islands. Regular jet transport to the major resort areas is in place, but once off the beaten track, air transportation is sadly lacking. In many instances, the only air transportation available is from aging seaplanes. The Caribbean is a region where the tiltrotor can make a definite impact. Vertiports can be established on the islands for a fraction of the cost of airport construction. Service can begin with only minimal facilities and the facilities can be incrementally improved as the demand and justification for continued service grows. The tiltrotor can be viewed as a cost-effective tool for economic development of the island nations.

Uses in the Pacific Rim

The Pacific Rim is being recognized as the next major economic center. There are a number of countries where tiltrotor aircraft can have a positive impact.

Australia is a vast continent where over 2 million square miles of the "outback" are isolated from the urban areas. Like Alaska, the only practical way of providing essential services such as medical attention is by air. The development of Australia's resources and the well being of its inhabitants cry out for a capability such as that offered by the tilt rotor.

China is an example of a country which needs large-scale air transportation for its development. The rugged terrain characteristic of that country makes the construction of roads or rail systems prohibitively expensive. Only the huge population and resulting cheap labor supply have made possible the existing transportation facilities. In order to implement an air transportation system to meet China's needs could consist of several large airports to provide long-range transportation and a system of relatively cheap vertiports using tiltrotor aircraft to service the remote regions. The untapped resources of China are legendary. Tiltrotors can help to develop those resources.

Indonesia is a unique nation comprised of more than 13,500 islands, spanning over 3200 miles. To adequately serve the population will require an immense investment in air transportation facilities. To build airports on all islands with major populations would not be feasible. The lower cost of construction of vertiports would make that goal attainable. Indonesia is striving to enter the helicopter market and is currently producing STOL aircraft. The transportation needs of this far-flung nation could be well served by tiltrotor aircraft.

The Japanese have stated their desire to improve their internal transportation system. Japan is a wealthy and advanced country; however, its road network is poor. They have used the "bullet train" with some degree of effectiveness, but high speed rail requires land-intensive rights-of-way in a country in which land is mountainous, expensive and precious. The expansion of a fixed wing commuter system is similarly constrained. At the 40th Annual Meeting of the Helicopter Association International, the Honorable Bunsei Sato, a member of the Japanese House of Representatives, announced plans to develop a network of 600 vertiports/heliports in a project named Heliport Highway 600 (HH600). This project will make VTOL transportation an integral part of the Japanese transportation system. The plan includes helistops in each "county" to full blown downtown vertiports in the major cities and at some 60 vertiports and large airports built offshore, connected to the mainland by VTOL aircraft. It is estimated that over 1000 helicopters and other VTOL aircraft will be needed to service this system.

Some view the ISHIDA TW-68 (a Japanese financed development of a tiltwing VTOL aircraft) as a novel way to exploit western developed technology. The tiltwing concept was developed in this country by Boeing Vertol (V-76) and LTV (XCH-142) and in Canada by Canadair (CL-84). This line of thought reasons that the Japanese will finance the development and production of the tiltwing aircraft in this country and use the aircraft to service its extensive VTOL transportation system. Some industry observers believe that, should the tiltwing development falter, a similarly sized tiltrotor aircraft could be developed at low risk in the same facility.

Europe and the Emerging European Democracies

Europe and the emerging democracies present an another export opportunity for American-produced tiltrotors. The location of the European population centers is such that a network of tiltrotor airliners would operating from urban vertiports would provide more responsive service that that presently provided. In the emerging democracies particularly, is there a golden opportunity. These countries do not possess an extensive aviation infrastructure. As they begin to improve their economies and standards of living, the United States has the chance to invest and participate in the improvement of both the air side and the ground side of their air transportation systems. The U.S. currently holds a clear lead in tiltrotor technology, but we could lose this lead to EUROFAR or the Japanese.

International Balance of Trade

The past twenty years have seen a steady erosion of the U.S. leadership position in the aviation industry. Increasing shares of the fixed-wing and helicopter markets have been lost to European and South American manufacturers. Currently, we hold approximately a 50% share of the world helicopter market and the trend is downward. The fixed wing industry is experiencing similar losses in market share. Many attribute this to the willingness of foreign governments to more fully participate in the development and marketing of their products, while the U.S. position is to maintain a "hands off" posture with our commercial developments. With the exception of the Beech 1900, all aircraft in domestic commuter service in the U.S. today are of foreign manufacture. Tiltrotor technology has the potential to revolutionize the short-haul transportation industry and reverse that trend. Conservative preliminary market estimates, considering the potential for city-center air transportation service and airport congestion relief, emergency medical service, corporate use, development of emerging nations, and a broad spectrum of military missions, indicate a world-wide civil market of between 5000 and 10,000 vehicles. As a point of reference, less than 1500 Boeing 727s have been built. This indicates an extensive impact in terms of international balance of trade and domestic jobs. The potential exists for development of an entirely new segment of the aviation industry, dominated by the United States.

EUROFAR

The United States is not alone in pursuing the tiltrotor concept. While the United States was proceeding with the development of technology demonstrators, European aerospace companies were producing conceptual design studies, conducting wind tunnel tests, and exploring potential markets. With the successes of the XV-15 program and the engineering development of the V-22 Osprey, Europe became a serious player in the tiltrotor arena with the Eurofar Program. Eurofar, the European Future Advanced Rotorcraft, is supported by a consortium of aerospace companies: France's Aerospatiale, Italy's Augusta and Aeritalia, Spain's CASA, West Germany's MBB, and Britain's Westland. It is conducting a well-structured program with the goal of developing and marketing a 30-passenger tiltrotor aircraft aimed at the commuter market. U.S. officials who have studied the Eurofar design believe it to be technically sound and achievable. It is Eurofar's intention to beat the United States to the marketplace with this aircraft. If we do not proceed with our military and civil tiltrotor development programs, they will succeed.

Additional Research Required

When the military jet airplane was ready to enter service, that technology was relatively mature, but there were a number of improvements that needed to be made, both in the airframes and the engines, as well as in the ground infrastructure and air traffic system. Many of these improvements are still being made today as jet transport technology evolves with improvements in basic technology. Similarly, tiltrotor technology is ready for military service and for some applications, for civilian service. However, there are research and development needs for the improvement and optimization of the concept.

High-Speed Rotorcraft Technology

The current tiltrotor technology can be improved with advances in basic aviation technologies, such as propulsion and engine systems, structures and materials, aerodynamics, flight control systems, and vibrations and aeroelasticity. It is desirable to have engines that can operate at higher temperatures and possess lower fuel consumption characteristics. Advanced materials and structural fabrication techniques can lower the overall weight of the aircraft and improve its efficiency. A particular example is the use of advanced composites to design wings with higher stiffnesses and reduced thicknesses. Thinner wings can provide higher aerodynamic efficiencies. Advances in aerodynamics and computer design codes can reduce the time and cost to design and produce new tiltrotor designs. Advanced flight control systems can eliminate conventional control surfaces, reducing complexity and weight. Research into vibrations and aeroelasticity can produce design codes that permit the manufacturers to produce aircraft with better vibrational characteristics and will extend the life of many components, lowering the operating and maintenance costs.

As important as the hardware research needs are the needs for improving the infrastructure in which the aircraft will operate. Development of terminal instrument procedures, airborne systems, air traffic control procedures, and vertiport design are essential. The vertiport environment will be more constrained by obstacles and approach and departure routes will have to be precisely defined and flown. Studies need to be made in optimal vertiport lighting design and approach aids, as well as the development of construction design standards. Also required is research into the way these aircraft will be integrated into the existing air traffic control system, and how the ATC systems will evolve to provide optimal service to a mix of different types of aircraft.

Yes, research of many types need to be done, and it needs to be done in advance of the aircraft entering the civil system.

What Research is Underway?

I am please to report to you that much of the required research is underway. NASA is undertaking a High-Speed Rotorcraft Program to investigate several concepts that will extend the cruise speed of rotorcraft to the high subsonic area. That agency is committed to supporting the FAA with key technologies for integrating tiltrotors into the National Air Transportation System. It is continuing its research into the basic enabling technologies, and is investigating ways of reducing download on the aircraft, further reducing noise levels, developing advanced simulation models, conducting studies of technology impact on civil market size, and developing technology in the man-machine area. Additionally, NASA is supporting the DoD in the FSD of the V-22 and has proposed a joint NASA/Navy Advanced Tiltrotor Technology Program.

The FAA is equally busy. developing certification standards, improving its Rotorcraft Master Plan, producing a Vertiport Design Guide, constructing a Vertiport at the FAA Technical Center, initiating research on tiltrotor terminal area operations, and many other important activities. The FAA has committed to the goal of planning for and implementing whatever is necessary to introduce tiltrotor operations into the National Airspace System. To accomplish this, the FAA has established a National Civil Tiltrotor Initiative and has assigned a most capable individual to manage that initiative. The FAA is being exceptionally proactive. Within the last year, the FAA has formed a Civil Tiltrotor (CTR) Office, introduced a CTR Program Plan and a CTR Implementation Plan, conducted a CTR R&D Workshop and a CTR Strategic Evaluation Workshop, provided 15 AIP grants for studies of tiltrotor applications for major metropolitan areas, produced an Interim Powered-Lift Certification Criteria document, developed MLS terminal area procedures, and established a CTR Coordinating Group with membership from concerned FAA functional groups, DOD, NASA, the Department of Commerce and Industry.

Conclusions

Tiltrotor technology has been proven to be sufficiently mature and ready for immediate military application. It has demonstrated a versatility and breadth of application potential unequalled by any other aviation concept, civil or military. For civilian application to become a reality and for the concept to reach its full potential, the military V-22 program must be allowed to proceed to production. America has a winner in the tiltrotor technology. If we do not exploit that technology, other nations will. You will eventually see tiltrotor aircraft serving our communities. Will they be American made?

Mr. Clifford M. McKeithan

Director of External Interactions
Center of Excellence for Rotary Wing Aircraft Technology
School of Aerospace Engineering
Georgia Institute of Technology
Atlanta, Georgia 30332-0150

(404) 894-2995 (Office)
(404) 894-2760 (Facsimile)
(404) 565-6729 (Home)

Mr. McKeithan graduated from the United States Military Academy at West Point, N.Y. in 1962 and served in the Field Artillery with the 82d Airborne Division at Fort. Bragg, NC. In 1965, he was trained as an Army Aviator at Ft. Rucker, AL then served his first tour in Viet Nam with the 1st Cavalry Division at An Khe flying the Grumman Mohawk aerial surveillance aircraft. Upon his return to the U.S. in 1967, he commanded a Warrant Officer Training Company at Hunter Army Airfield. He was also the Airspace Control Officer for the Installation and received air traffic control training from the FAA. Following attendance at the Field Artillery Advanced Course, he returned to Viet Nam in 1969 and was the Airfield Commander of Di An Army Airfield. He then served as the Executive Officer, Headquarters Command, at Fort Sill, OK. In 1971, he entered civil schooling and earned his Master's degree from Georgia Tech. From 1973 to 1976, Mr. McKeithan was an Associate Professor of Chemistry at West Point. In 1976, he was qualified in helicopters and then went to Germany and served as the Executive Officer of the 14th Air Traffic Control Battalion. His unit was responsible for air traffic control and flight following services for all Army aircraft in West Germany. Following attendance at the Army Command and General Staff College at Fort Leavenworth, he was assigned as the R&D Coordinator for the Director of Engineering, U.S. Army Aviation R&D Command in St. Louis. He assisted the Director in the supervision of the engineering functions for AVRADCOM and the evaluation of proposed changes to major aircraft systems and support equipment. He was also responsible for the improvement of the Command's computational capabilities, technology transfer efforts, and the monitoring of Army basic research programs. He also maintained close liason with helicopter manufacturers. In 1979, Mr. McKeithan was selected to be the the Army Deputy Program Manager of the XV-15 Tilt Rotor Research Aircraft Program at the Ames Research Center, Moffett Field.CA. In that capacity, he was responsible for the military feasibility testing of the aircraft and served as the Government Flight Representative for all of the off-site demonstrations of the XV-15. He was also responsible for articulating the capabilities of the tilt rotor concept to potential civil and military users. He developed testing schedules and budgetary requirements and secured funding support from the Army and NASA. He formulated and supervised a series of military mission suitability tests for the XV-15 which demonstrated the maturity of the tilt rotor concept and led to the acceptance of the technology as the basis for the V-22 Osprey program. He coordinated the NASA and Army laboratory support of the Osprey program until the formation of the Naval Air Systems Command Program Office. Upon his retirement from the military service at the end of 1983, he joined NASA as the Deputy Manager of the joint Army/DARPA/NASA Heavy Lift Research Vehicle, an attempt to complete the construction and flight test the XCH-62 heavy lift helicopter. Upon the cancellation of that program for lack of Army funding support, he served as the Rotorcraft Programs Coordinator for the NASA Ames Research Center. He monitored in-house and contracted rotorcraft research and development programs and provided periodic status reports to government and industry. He managed the DOD/FAA/NASA study of the National Implications of the V-22 Tilt Rotor Aircraft Development, including civil and military application, impact on the defense industrial base, and technology spinoff opportunities. He participated in the collateral study conducted by the Port Authority of New York and New Jersey and provided advice during periodic reviews of that effort. He worked with the FAA to promote the funding of similar studies of civil applications of tilt rotor aircraft at the major population centers of the U.S.

In early 1988, Mr. McKeithan joined the faculty at Georgia Tech, where his duties include promoting rotorcraft research programs for the Army-sponsored Center of Excellence for Rotary Wing Aircraft Technology. He acts as a resource for public agencies on tilt rotor technology and conducts periodic seminars in the Atlanta area to educate interested parties and agencies as to the potential of the tilt rotor aircraft to provide congestion and noise relief.

In addition to his military qualifications in both helicopters and fixed wing aircraft, Mr. McKeithan holds an FAA commercial instrument rating in multi-engine and single engine airplanes and in helicopters.

Mr. **Torricelli**. Thank you, Mr. McKeathan, very much. Thank you, each, for your testimony.

Perhaps one of you could address—

Mr. **Rohrabacher**. Mr. Chairman, I have to go to the floor to participate in debate on the balanced budget—

Mr. **Torricelli**. Would you like to make inquiries beforehand?

Mr. **Rohrabacher**. Just—

Mr. **Torricelli**. Please proceed.

Mr. **Rohrabacher**. Thank you very much, Mr. Chairman.

What do you see as the market for this—for the V-22, and how soon would these planes be available if the—if all went as you would see—as you would desire, if the military procured the airplanes, if the research and development continued at the level that you would like it to continue, how soon would it be before we would actually be able to sell these aircraft to Japan or to other countries or to our own commercial aircraft industry and what—and how big is the market?

Mr. **Renouard**. We've run several studies, Mr. Congressman, on that and it looks like the time period is between 1997 and the year 2000 is when you'd be actually producing production vehicles. There's been several studies made. There's been a NASA/DOD study made, phase 1, we're participating—Bell and ourselves—along with our commercial airplane brothers and a phase 2 study that the results are going to be released a month after next. The market—the original market was around 1500 aircraft. It now looks like that may double. We may be in the 3000-aircraft mode. This is all contingent on the V-22 going forward at—prior to the civil aviation prospect.

Mr. **Rohrabacher**. If the—if it does not go forward—by the way, I'm not an opponent necessarily of this. I'm—in fact, I would be in favor of this project. I'm just not certain exactly whether we have the money and whether the military's going to be spending the money on it, even if we desire to—have that desire.

If the military decides not to procure this aircraft, but we move forward with research and development, does that kill the program or does that postpone the program? What effect will it have and how long will that postpone the program or will it kill lit?

Mr. **Horner**. One of the aspects that we've looked at in one of the studies that we did was if there's no program, we looked at what would happen and we looked at the introduction of commercial airplane would be delayed like—I think it was seven to eight years—delay before you could get it into—and economically, it was very questionable of whether or not the investment would be worthwhile for the time frame and the number of airplanes, once again, without that stamp of approval.

My own reaction to that statement is that—and I've made this before, is that I would then have to go into the international market and look for a source of funding which, in essence, is a shared manufacturing program, as we do with commercial helicopters in the world due to offset requirements, and see if we could find somebody out there that would be willing to step up to the—up to the bar and go forth with a program.

Looking at the international use of the tiltrotor technology between areas—and I'll take an example. Let's use Indonesia, which is where we built our helicopters, but you know, it's 2000 miles long and you can't count the number of islands, ideal situation for a tiltrotor technology.

So my belief is you'd be looking at least a eight- to 10-year delay and probably longer and it would take a much different organized program to put it together.

Mr. ROHRABACHER. I would suggest that the market's much bigger than you are even looking—what you are imagining today, just the Indonesia example, throughout the Third World where I've traveled, this plane would be an ideal system and I hope it goes forward and I hope I didn't leave you with the impression that I'm opposing the project because I'm not. It's just that going down there to talk about the balanced budget, I just recognized the challenges we face right now with our budget situation.

Mr. RENOUARD. You know, Mr. Congressman, there's been a lot of quotes made on Boeing and the various models that we've had, but it's a big investment. As you know, you're vesting the price of the company every time you go forward. There's a lot of talk in the papers these days about the 767-X, the future 777. The company has not announced the program until they get a lot of customers signed up. There's a lot of anticipation that that's going to happen. So it sounds trite when we always say that the customers, you know, launch the programs. We don't, but it's really true. They've got to have a feeling of confidence and realize the reliability is there. That's why we're saying the military or some large program where you could really get the corners of the envelope stretched—

Mr. ROHRABACHER. One last question and then I've got to run.

What is the cost relationship or comparison between the V-22 versus this light helicopter that the military wants as well, which doesn't, I believe, have any civilian application?

Mr. RENOUARD. They're both, from a DOD standpoint, looked at in the same approximate life cycle. You know, we're talking 25 billion, I believe it is they talk about both of them. There are different requirements totally. The LH, of course, is a fighting machine. The V-22 is a different mission, totally.

But I would say that the total size of the programs are somewhat similar.

Mr. ROHRABACHER. Okay. Thank you very much.

Mr. RENOUARD. The other difference is that we're partners on one and opponents on the other.

[Laughter.]

Mr. ROHRABACHER. Mr. Chairman, I appreciate the courtesy of letting me ask my questions.

Mr. TORRICELLI. Not at all.

Gentlemen, if any of you could describe for me what is—how would you describe the current state of the European program and if the United States is removed as a participant or, indeed, if we are not, when would you estimate a commercially viable European tiltrotor into the marketplace?

Mr. HORNER. The status of the EUROFAR program, to my knowledge, is that they are in the study wind tunnel phase. There has been no decision there, to my knowledge, to actually put hardware on the table, other than maybe some test parts into fatigue—

Mr. **Torricelli**. I know this involves a significant measure of guess, but I—but we've talked about a civil vehicle here potentially flying in '96, a market developing at the turn of the century in significant numbers. Distinguish that from the way a program that is now in the wind tunnel phase with this kind of technology might naturally evolve, given their current state.

Mr. **Horner**. I believe that they would be at least 10 years and probably longer before they could bring the aircraft to the marketplace.

Mr. **Torricelli**. That is the kind of comparison I was looking for.

Mr. **Horner**. It depends on what—how much data they've gotten out of the XV-15 NASA data that's available that they can actually utilize.

Mr. **Torricelli**. Considering our track record, probably all of it.

How would you characterize the potential size of a domestic and international market—let's put a time parameter on this—into the first decade of the next century? What—how many units are we potentially talking about domestically and internationally? The military aside, all militaries aside.

Mr. **Renouard**. As I was answering Mr. Rohrabacher, the first study that was completed a year ago showed about 1500 aircraft—

Mr. **Torricelli**. Internationally.

Mr. **Renouard**. This total, and we're finishing up phase 2 on the study now. The preliminary data showed that will probably double. We're probably talking in the 3000 range as far as civil aircraft potential.

Mr. **Torricelli**. Give me a estimate on a opening, a potential opening price of a civilian unit in a—in this century. What could a carrier potentially be looking at as a price, assuming there's a V-22, assuming we bring it through to a demonstration level, what are we potentially talking about?

Mr. **Renouard**. The life cycle cost of the V-22 itself is 16 million a copy. That's in 1988 dollars, if you looked at the total quantity of 800-plus airplanes. We would think around $20 million, I think, is a general range that we'd be in.

Mr. **Horner**. On the V-22, and we think that the commercial version will be slightly lower than that because you don't have the various items, although you mentioned we might need those in the New York area, the folding mechanisms and the IR suppressors and some of those items that you—

Mr. **Torricelli**. So somewhat less than $20 million—

Mr. **Horner**. Yes.

Mr. **Torricelli**. —assuming that there's no large fleet discount or—and assuming there's a V-22 program and a demonstration project, in this century, you can bring it to market?

Mr. **Horner**. Yes, sir.

Mr. **Torricelli**. If there is not a V-22 program—I have spoken with some of your companies. I've spoken with my colleagues about interest in this committee in the wake of that defeat, which obviously all of us are going to work to avoid, in establishing a DOT, then, sponsored civil demonstration project. Would you react to that?

Mr. **Horner**. My reaction is that there's two parts of that system. One is the—that we could utilize some of the prototype airplanes that are being flown, the V-22, in a systems application, recognizing the fact that development aircraft don't get up every morning and go to work like regular aircraft do, to prove out the fact that you could move goods and equipment of some magnitude within some type of a system, maybe with somebody like FedEx or the people down in the Caribbean.

I would then envision the fact that we would, as I mentioned before, jointly come up with a mechanism to build a pressurized aircraft which would truly be able to utilize that which we've gained out of the V-22 development—

Mr. TORRICELLI. So describe for me what—how you would have this committee proceed if we fail in our efforts to continue the V-22? Would you have us set up a DOT demonstration project for a pressurized vehicle and then have it used in some capacity to gather experience?

Mr. HORNER. Yes, sir. And I would—I went through briefly, and it's in my testimony here, setting up this organization which I believe can fulfill that because there's more to it than just the aircraft again. We come back to—

Mr. TORRICELLI. I understand that.

Mr. HORNER. —the air traffic control—

Mr. TORRICELLI. And having not had the ability yet to have read your testimony—I only heard half of it when I returned back to the room—which agency of the government would you recommend as best suited to do—

Mr. HORNER. Department of Transportation.

Mr. TORRICELLI. It is? You say that without qualification and having considered the variety of other options, you're convinced they are the best—

Mr. HORNER. I think the FAA, NASA, the—probably a government agency that would be helpful in the development of further aspects of the airplane would certainly be members of that organization, as well as industry.

Mr. RENOUARD. I'd like to add to that, if I could, Mr. Chairman. I—we're encouraged by the enthusiasm that you folks have for this airplane, as well as ourselves, and you know, you never give up. I would believe that you would use some of the assets. There are six aircraft that we've developed here and you could use one for NASA, a technology demonstrator. You could use one for FAA, Department of Transportation, to try to smoke out some of the problems that you might have with a commercial sector. There's all kinds of possibilities. You know, you put—I think we kicked the R&D can down the road a little ways, but I think—

Mr. TORRICELLI. As long as somebody has primary responsibility—

Mr. RENOUARD. —you could use the assets we have—

Mr. TORRICELLI. —as long as somebody has responsibility on the demonstration and bringing it to these agencies. But you share the DOT judgment?

Mr. RENOUARD. Yes, sir.

Mr. TORRICELLI. In what areas should the FAA be increasing its own efforts? I've talked before about air traffic control and wanting to see their thinking on how to deal with it. We've talked earlier about the siting of vertiports. I've mentioned my own interest in noise and capacity. Is there anything I'm missing here where we should have the FAA be doing more work to pave the way for a commercial—

Mr. **Horner**. I think those are the avenues that we've discussed. I can't—

Mr. **Renouard**. Air space management, how you manage to come up to the airport—

Mr. **Torricelli**. So the committee, then, is on the right track in pushing the FAA to do all these things.

Mr. **McKeithan**. I might add, sir, the FAA is, on its own, doing a lot of things without being pushed, too. In the years of flying I had and the different relationships with the FAA, I've never seen them as disenthusiastic about a new technology.

Mr. **Torricelli**. Sir, that was exactly my next question.

Mr. McArtor claimed, and I believe there's some evidence that this, indeed, was a high priority—are each of you convinced that that remains the fact under Administrator Busey? Does anyone want to take issue with that contention?

Mr. **Horner**. Admiral Busey, of course, was the head of NavAir at the point in time that the V-22 came into the world, so to speak, and was very instrumental in that program. He's flown in the XV-15. He's been very supportive of tiltrotor technology in speeches that I've heard him make.

I haven't—I haven't seen any testimony that he's made before Congress, so I'm not aware of what testimony he may have made before Congress, but publicly, he certainly has supported tiltrotor technology.

Mr. **Torricelli**. In your experience with the FAA to date, and as you see them proceeding and reacting to developments in the technology, you are each convinced that it's remained a priority?

Mr. **Horner**. I think it's amongst their priorities. I believe the FAA, without question, has a tremendous priority problem in putting together a new transportation, as I call it, subsystem to move air traffic control. I'm on the R&D Advisory Committee to the FAA, and it's obvious to me that one of the major tasks that's in front of them is putting in an air traffic control system.

Naturally we talk in the mode, how do you get vertical takeoff and landing within the air traffic control system, but to me, that's their—obviously their number one priority, next to safety. Safety is obviously everybody's in this room's first priority. But—so I fit air traffic control in and then right underneath that is how do we get—how do you move people within their transportation system, and I think the tiltrotor has a priority within that system. It will never be high enough for me, but—

Mr. **Torricelli**. Let's just change the issue for a moment. I'm told that the Senate Armed Services Committee in its markup of this year's defense bill, denied long-term procurement on the basis of what we know as fly before you buy, citing technical difficulties encountered during the flight test program. Would you characterize for me these technical difficulties that, in their judgment, has made this not ready for production?

What is it that's being referred to?

Mr. **Renouard**. I don't think there is any major technical difficult. The flight test program is doing what all flight test programs of flying machines are supposed to do. It's smoking out all the problems and then you can go fix them.

Mr. TORRICELLI. From the Senate's perspective, what is they could be credibly—

Mr. RENOUARD. The only thing I know, Mr. Chairman, and I'll give you a few data points. The—basically, we don't think there is any show-stoppers. The handling qualities do meet the specifications. That's been verified by our engineers and our pilots. Vibration and fatigue loads do meet the allowables. They meet the specifications. The aeroelastic stability is acceptable throughout the initial flight envelope which we have flown.

There's three—there's three problems that we're currently having and we're working on. One is in hover. One is in maximum level flight speed. They're both below target. The—we're 500 pounds shortfall in the hover lift. This is out of 47,500 pounds, so we're talking 1 percent. The margin is over and above the mission—

Mr. TORRICELLI. Is that the weight that would be required for a full passenger load aircraft?

Mr. RENOUARD. Fully loaded.

Mr. TORRICELLI. I'm not talking about military, but if—

Mr. RENOUARD. Yes, sir. Yes, sir.

Mr. TORRICELLI. And how many passengers would that—

Mr. RENOUARD. Twenty-two.

Mr. TORRICELLI. Twenty-two, and you're 1 percent off.

Mr. RENOUARD. One percent off and that—and this is margin over and above the mission requirements. We're talking about the outer edge. We're going to take steps; we're going to fix that during the flight test program.

The other one is the maximum level flight speed is 270 versus 275 knots. Again, the cruise speed—

Mr. TORRICELLI. So you're five knots off where you want to be—

Mr. RENOUARD. Five knots off cruise speed is 250 that the Marine Corps will be using and most of their missions, we're talking about DASH speed now. We're talking about five miles an hour.

Mr. TORRICELLI. What is the hover—how far are you off on your hover requirements?

Mr. RENOUARD. The hover is 1 percent. We're 500 pounds shortfall today out of 47,500 pounds, maximum lift capability, so we don't consider those things major technical problems.

The third—

Mr. TORRICELLI. On the civilian side, I know, speaking theoretically—

Mr. RENOUARD. Sure.

Mr. TORRICELLI. —if we were dealing with a civilian aircraft here, in a ball park, how many passengers are we likely to be talking about on a civilian aircraft?

Mr. RENOUARD. This first study had two studies. One was 35, I believe, and one was 75.

Mr. TORRICELLI. Seventy-five?

Mr. RENOUARD. So we're talking about—

Mr. TORRICELLI. It must be a comfortable seating arrangement—

Mr. RENOUARD. —you know, different size, and obviously you don't have the fold-up mechanisms that you have with the V-22—

Mr. **Torricelli**. Fold-up knees.

Mr. **Renouard**. Right.

[Laughter.]

Mr. **Torricelli**. If—let's—not taking this to the extreme, saying we're talking about a 50-passenger aircraft, what is the difference in weight likely to be? Are we still—are we talking about less weight on the civilian aircraft, even though we have 50 passengers?

Mr. **Renouard**. Oh, yes. You'd be carrying much less of the mechanism—

Mr. **Torricelli**. So isn't it likely on a civilian aircraft, if you were developing it at the moment, speaking theoretically, that you're likely to already be inside comparable requirements?

Mr. **Renouard**. I would say so, yes.

The third area if the weight of the airplane itself, and we're slightly overweight and we have plans right now to reduce the weight to the spec requirements.

Mr. **Horner**. I basically, though, have asked the NavAir program manager the same question you asked here. What are the technical problems you referred to, because I wasn't aware of technical problems that had been brought forth to the committee and I'm trying to find that out myself.

Mr. **Torricelli**. Basically, we're talking about weight reduction. Isn't weight reduction part of each of these that you just talked about?

Mr. **Horner**. Absolutely—

Mr. **Renouard**. Right.

Mr. **Horner**. —and that's not anything unusual—

Mr. **Torricelli**. Which isn't exactly very high-tech to overcome.

Mr. **Horner**. That's correct.

Mr. **Renouard**. Very straightforward.

Mr. **Torricelli**. Gentlemen, this's been extremely helpful, helpful in the first instance, in at least preparing this member and I hope other members of the committee for the fight that is about to occur on the Floor of the Congress, but more than that, helpful because this committee is determined to play a role, win, lose or draw, in that fight on the development of a civil component of this technology, a fight we do not intend to lose.

Thank you very much for your testimony today.

Mr. **Renouard**. Thank you, Mr. Chairman.

Mr. **Torricelli**. Our third panel, if we could, Joseph Del Balzo, Executive Director for Systems Development, FAA; Robert Rosen, Deputy Associate Administrator for the Office of Aeronautics, Exploration, Technology, NASA.

Gentlemen, I have one phone call, I'm afraid. It's the Speaker. It's not wise to keep him holding. I will return in one moment, if you would forgive me.

[Recess.]

Mr. **Torricelli**. Mr. Rosen, Mr. Del Balzo, welcome. Thank you for coming before the committee today. The Congress is going to be voting on the balanced budget amendment sometime in the next 40 minutes, so I'm going to ask you to please be as brief as possible with your testimony so we get a chance to engage in some dialogue because there are a number of things I'd like to ask each of you before the vote occurs.

It is, I understand—the clock on the wall says 20 after 5. We're on Bermuda time here, but actually it's only 20 after 4, so we do have—we do have some time.

Mr. Rosen, would you proceed?

STATEMENTS OF JOSEPH DEL BALZO, EXECUTIVE DIRECTOR FOR SYSTEM DEVELOPMENT, FEDERAL AVIATION ADMINISTRATION; AND ROBERT ROSEN, DEPUTY ASSOCIATE ADMINISTRATOR FOR THE OFFICE OF AERONAUTICS, EXPLORATION, AND TECHNOLOGY, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Dr. ROSEN. Mr. Chairman, I've furnished a statement and I'd like to give you an oral summary of that, if I might.

Mr. TORRICELLI. Please.

Dr. ROSEN. I appreciate the opportunity to outline NASA's perspective on civil applications of tiltrotor technology. Although the principle application of this technology thus far has been the development of the V-22 Osprey, we believe that there are important civil applications, including scheduled passenger service.

In our aeronautics program, we are pursuing research which will contribute to civil applications. We are also cooperating with other government agencies, such as the FAA, to enhance the accomplishment of both our missions. The development of certification criteria for tiltrotor vehicles is an example of just one of the many cooperative efforts.

As you're well aware, NASA's role in aeronautics is to provide emerging technologies and innovative concepts for superior U.S. aircraft and to provide for their safe and efficient operations. This role includes selective technology validation of high pay-off areas. The cooperative development of tiltrotor technology is an example of just how well we work in cooperation with industry and other government agencies to implement our aeronautics role.

The tiltrotor idea is over 60 years old, but that idea had to wait until the enabling technologies were available before it could become a reality. For example, the XV-3 first flew in the 1950s, but was seriously underpowered and suffered from aeroelastic instability. However, through analyses and ground-based experiments, government and industry researchers and engineers solved the power and aeroelastic problems and their efforts eventually led to proof-of-concept flight testing and to the development of the NASA/Army XV-15 tiltrotor research aircraft in 1971.

Every step of the technology development was crucial. The industry/government team of NASA, DOD and Bell Helicopter provided the appropriate level of resources, technology and expertise to design a complex new type of aircraft that would be acceptable to the user community.

In 1987, in anticipation of the fielding of the V-22, the FAA, NASA and DOD commissioned the Boeing Commercial Airplane Company to conduct a study of civil applications of the tiltrotor. Boeing's study determined that the tiltrotor could play a significant role in the air transportation system and that the potential for a market, a major market, exists. Unfortunately, the risks associated with certification, the civil aviation infrastructure, public acceptance, operational costs and the technology maturity needed to—for a viable civil version were high, and industry did not want to pursue civil development alone.

The 1987 study generated wide interest and raised technology questions and opportunities which led to a follow-on or Phase 2 study that our prioritizing technology opportunities that offer the highest pay-off. In addition, the Phase 2 study will better quantify the cost savings opportunities of applying particular civil design operating practices.

Preliminary findings indicate that tiltrotor purchase and maintenance costs may be significantly lower than originally estimated. One of the main efforts of interest to us will be to the possible technology improvements to the projected market size and user acceptance.

Because of its significant potential for civil missions, NASA continues to pursue tiltrotor research. We are supporting DOD tiltrotor development and are working closely with the FAA to help reduce the risks associated with introducing civil tiltrotors into the National Airspace System. If tiltrotor costs can be lowered sufficiently by improved technology, then the economic tradeoffs will favor earlier industry development.

NASA's current rotorcraft research activities focus on vehicle performance improvements and activities that, in cooperation with the FAA, will assist in integrating tiltrotors into the civil aviation infrastructure. I'd like to highlight just a few of these efforts.

We are testing small and large-scale models and conducting sophisticated analyses to reduce rotor downwash loads on the wing during hover. This could allow an increased payload of 25 percent. Since weight is key for any vertical takeoff aircraft, we are generating advances in composites research that could eventually reduce weight and manufacturing costs and increase the economic design life of tiltrotor fuselages.

We are also conducting research that will help us better understand, predict and control tiltrotor noise and vibration, and more safely and efficiently integrate the tiltrotor into the National Airspace System. And we are examining advanced tiltrotor configurations for greater speed.

While we are clearly—while there are clearly technical issues remaining, NASA believes that the introduction of the tiltrotor as a civil air carrier is a systems integration problem and adequate civil tiltrotor infrastructure must be in place, both on the ground and in the air. Technology issues must be well understood. Certification criteria must be properly spelled out, and above all else, ownership and operational economics must be capable of being guaranteed.

Federal, state and regional agencies, local governments, industry, the financial community, aircraft operators and numerous local special interest groups, must all come together at the same time with resources committed up front. Development cannot depend upon any one group or individual.

A strong constituency is needed. A phased approach, including appropriate demonstrations, may be one solution to addressing this complex problem.

NASA believes the tiltrotor has potential for civil application and we are meeting some of the technology challenges to realize that potential. Much has been done since the early NASA work in the 1950s, but much remains to be done. It will take a team approach to successfully bring tiltrotor technology to the National Airspace System. NASA is committed to its part.

Thank you, Mr. Chairman, that concludes my remarks.

[The prepared statement of Dr. Rosen follows:]

NASA
National Aeronautics and
Space Administration

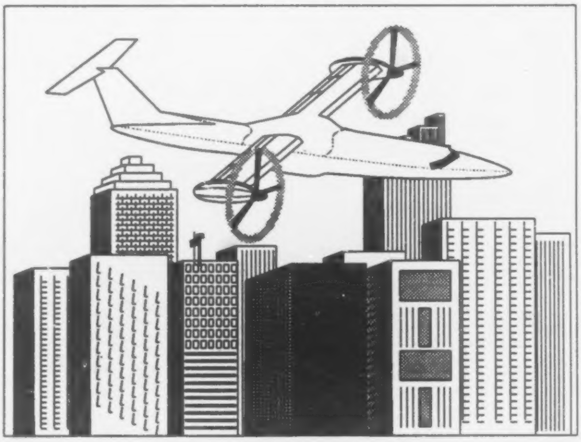
Hold for Release Until
Presented by Witness

July 17, 1990

Subcommittee on Transportation, Aviation and Materials

Committee on Science, Space and Technology

House of Representatives



Statement by:

ROBERT ROSEN
Deputy Associate Administrator
Office of Aeronautics,
Exploration and Technology

101st Congress

STATEMENT

of

Dr. Robert Rosen
Deputy Associate Administrator for
Aeronautics, Exploration and Technology

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

before the

Subcommittee on Transportation, Aviation and Materials
Committee on Science, Space and Technology

United States House of Representatives

Mr. Chairman and Members of the Subcommittee:

I appreciate this opportunity to discuss with you the NASA perspective on civil applications of tiltrotor technology. While the principal application of this technology thus far has been the development of the V-22 Osprey for the military, NASA believes that there are important civil applications for tiltrotors, including scheduled passenger service. NASA's aeronautics program is pursuing long-range, high-payoff research leading to technology options with the potential to contribute to these civil applications. In addition, NASA cooperates with other government agencies, such as the FAA, to provide technical expertise and unique research facilities in a way that enhances accomplishment of both agencies' missions. The development of certification criteria for tiltrotor vehicles is one example of a current cooperative effort.

Before proceeding I would like to place the tiltrotor in the context of NASA's role in aircraft research. I will then comment on its potential for civil applications, touch on our current tiltrotor activities and discuss some of the opportunities for future research.

Finally, I will describe a study that is underway that will better define the technology needs for civil tiltrotor aviation.

THE ROLE OF NASA RESEARCH

NASA's role in aeronautics is to provide emerging technologies and innovative concepts for superior U.S. civil and military aircraft and for their safe and efficient operation. This role includes selective validation of high-payoff areas in cooperation with industry and other government agencies. The successful implementation of research and technology programs in this context underpins U.S. military and economic strength in aeronautics.

The cooperative development of tiltrotor technology by NASA, industry and DoD is an excellent example of the implementation of NASA's role.

The tiltrotor concept is over 60 years old, but it had to wait until the enabling technologies were available before it could become a reality. The Transcendental Model 1G and the XV-3 developed by NASA, DoD, and Bell Helicopter in the 1950's had initial, although limited, success in demonstrating the basic feasibility of the tiltrotor concept. The XV-3 demonstrated the first full conversion from helicopter to airplane mode, but it was seriously underpowered and suffered from aeroelastic instability.

Despite these obstacles, engineers at NASA continued to investigate tiltrotor technology. This was done in conjunction with the Army, Bell Helicopter and later Boeing Helicopters. Through analysis and ground-based experiments they challenged and solved the aeroelastic problem. NASA conducted two sets of full-scale tests in the 40x80-Foot Wind Tunnel at the NASA Ames Research Center that validated these aeroelastic stability solutions. At the same time piloted simulations were conducted to address the unique aspects of tiltrotor flight. Success in these research efforts led to contracts with Bell and Boeing to explore a suitable configuration that would demonstrate the full flight envelope of a tiltrotor. This led to the development of the XV-15 by Bell Helicopter beginning in 1971.

Using the lessons learned during the XV-3 program and the subsequent ground testing effort, the XV-15 underwent extensive full-scale testing and piloted simulations. Hundreds of hours were amassed in all flight modes before the first forward flight test in 1977.

In 1979, the Navy joined the program after studying the merits of the tiltrotor as a productive and versatile replacement for a variety of Marine Corps and Navy missions. Demonstrations of military mission applications were conducted including shipboard operation and over-water rescue.

This is teamwork at its best. Every step of the technology development was critical. The industry/government team of NASA, DoD, and Bell Helicopter provided the appropriate level of resources, technology, and design expertise to bring a complex, new type of aircraft to acceptance for application by the user community.

POTENTIAL FOR CIVIL APPLICATIONS

Successful experimental aircraft programs, such as the XV-15, can provide validation of new vehicle concepts, but a great deal of risk remains for product development. There is very little operational or manufacturing experience in an "X" aircraft program on which to base an economic decision for a commercial aircraft. If the DoD has a need for the new capabilities offered, the first-generation vehicle is often a military vehicle. That military vehicle provides a data base of operational experience that helps reduce the uncertainties for potential civil users and regulators. It can provide confidence in estimates of capabilities and reduction in operational uncertainties and costs. Significantly increased understanding of the potential impact on the air transportation system, including ground infrastructure and air traffic control requirements results. A basis for civil certification is provided. Civil tiltrotors may fall into this category and could be accelerated by successful development and operation of a military aircraft.

In 1987, anticipating the fielding of the V-22, the FAA, NASA and DoD commissioned the Boeing Commercial Airplane Company to conduct a study of civil applications of the tiltrotor. This study determined that the tiltrotor could play a significant role in the air transportation system and the potential for a major market exists. Unfortunately, the risk at that time was high and provided a strong disincentive for industry to pursue civil development alone. The risks included certification, infrastructure, public acceptance, operational costs, and technology maturity needed for a viable civil version of the V-22. The study showed that higher purchase and operating costs of a civil tiltrotor commuter, which would manifest itself in higher ticket prices, would have to be offset in the eyes of the traveler by increased productivity from time saved and reduced costs of ground transportation.

NASA continues to pursue tiltrotor research and technology because of this potential for both military and civil missions. We are supporting DoD tiltrotor development and are cooperating closely with the FAA to assist in risk reduction efforts associated with introducing civil tiltrotors into the National Airspace System. If the tiltrotor costs can be lowered sufficiently by improved technology, then the economic trade-offs will favor earlier industry development and civil operation of tiltrotor vehicles.

CURRENT AND FUTURE NASA TILTROTOR RESEARCH

Among current NASA rotorcraft research activities are those that focus on improvements to the performance of the vehicle itself and those that, in cooperation with the FAA will assist in integrating tiltrotors into our civil aviation infrastructure. For example, reducing rotor downwash loads on the wing in hover directly results in increased payload. NASA is testing small and large scale models and conducting sophisticated analysis that shows that payload improvements of 25% are possible.

Weight is key for any vertical takeoff aircraft. NASA's generic materials and structures program in composites research is generating advances that can eventually reduce the weight, manufacturing costs and increase the economic design life of tiltrotor fuselages.

Research is being conducted to better understand the sources and characteristics of tiltrotor vibration and noise. NASA is measuring noise signatures and sources and validating computer codes to predict noise footprints around vertiports and in flyover. Generic rotor noise reduction research is underway that seeks innovative ways to further reduce noise on rotors that would benefit helicopters and tiltrotors alike.

Low interior noise and vibrations contribute to passenger acceptance and lower operating costs. Advanced rotor control techniques can provide a variety of benefits to tiltrotors. Gust suppression and an ultra-quiet mode may be possible. Wind tunnel tests and computer simulations are necessary to show feasibility.

NASA is testing advanced technology blades on the XV-15 that promise increased performance and significantly quieter operation. These blades are helping us understand key dynamic and aeroelastic phenomena.

The best flight profiles for noise abatement and safety are being investigated in NASA simulators in a joint effort with the FAA. Low noise and safe profiles are available, but it will be necessary to make it easy for the pilot to routinely fly these profiles in a civil airspace environment.

Studies have shown that emergency-rated power improvements can greatly increase the efficiency and flexibility for designs which are today limited by the possibility of engine failure. Research is required in health-monitoring, life prediction, and innovative cooling technologies to allow emergency ratings well beyond those now certified.

Cockpit automation and handling qualities are important areas of investigation. Technology in the cockpit will have a direct relationship in determining the type of vertiports from which a tiltrotor can operate in adverse weather. Successful integration into the National Airspace System using the unique tiltrotor capabilities may require improved cockpit technologies in the areas of displays, automated control, and flight directors.

Advanced configuration concepts that can increase speeds to well over 350 knots are being examined. These include forward sweep, canard surfaces and wing/rotor tailoring which take advantage of recent advances in computational capabilities.

Many technology opportunities for tiltrotors exist. NASA has chosen those most critical areas for focus that are consistent with our overall aeronautics strategy, objectives and budget.

PHASE II CIVIL TILTROTOR APPLICATIONS STUDY

The 1987 study, previously discussed, generated wide interest and raised technology questions and opportunities - many of which I have touched upon here.

A Phase II study, is currently underway with Boeing Commercial Airplane Company and its partners, Bell Helicopter Textron and Boeing Helicopters. This study is funded by NASA and the FAA, with cost sharing by the contractors. Critical research activities and their appropriate timing are being defined. The study will also define possible flight demonstrations that address many of the risks that I have mentioned. One of the main efforts of interest to NASA is the effect of possible technology improvements on the projected market size, user acceptance and system cost of civil tiltrotors. This will provide information to prioritize the technology opportunities for highest payoff.

Preliminary findings indicate that purchase and maintenance costs may be significantly lower than originally estimated. For example, study results show that an aluminum fuselage, rather than the composites used for the V-22, would be more cost effective with less technical risk for initial civil application. In addition, design loads and duty cycles for tiltrotors in passenger operation appear to be much closer to turboprops than helicopters. These loads directly contribute to maintenance requirements and costs. Helicopters typically have several times the maintenance burden of turboprops, so approaching the turboprop levels by a civil tiltrotor is welcome information.

The market estimate in the original study of 1400 aircraft for the year 2000 in the 40 passenger size has been confirmed and includes derivatives for cargo, public service, and private use operation. This market projection, however, is for a "market-responsive design", which may depart significantly from the V-22 design base.

Many of the projected uses can take advantage of the ground infrastructure at existing private general aviation airports. However, the air traffic control system must be expanded to accommodate scheduled Instrument Flight Rules (IFR) operations into those sites.

There will still be requirements for new city-center vertiports, and location is critical for market demand and cost of construction. Air rights around these vertiports, a major factor in their costs, are derived from clear space requirements. These requirements are heavily dependent upon approach and departure angles under safe IFR operation. Recent NASA/FAA simulations have shown that angles steeper than the current norm are possible for the tiltrotor. This should result in significantly less clear space required, hence reduced cost for air rights.

Other results of the Phase II study are being reviewed. The final report is due to NASA in August of this year.

A SYSTEMS PROBLEM

While there are clearly technical issues remaining, NASA believes that the major impediment to the introduction of the tiltrotor as a civil air carrier is the difficulty with the development of the overall system. There are many diverse elements that must be put in place for the tiltrotor to be commercially viable. These include the airplane itself and its proper certification criteria; financing, design standards and community acceptance to allow an appropriate system of vertiports; new ATC procedures that take advantage of the tiltrotor's special capabilities while integrating it into the existing air transportation system and more. To make this happen, the many key players must come together with commitment of resources. These players include federal, state and regional agencies, local governments, industry, the financial community, aircraft operators and numerous local special interest groups. The rewards and potential for success must be quite high before one can expect this group to form the necessary partnership.

CONCLUSION

NASA believes the tiltrotor has potential for civil application and has research underway to meet some of the technology challenges to realize this potential. We believe that the technology base is sufficient for a military V-22, but the technology base for civil use is in its infancy. NASA is working with the FAA to study the impact on airspace and certification standards. Industry, operators, and airport authorities are becoming active in assessing the tiltrotor. But much work needs to be done.

Thank you, Mr. Chairman. That concludes my prepared statement. I would be pleased to address any questions you may have.

Mr. **Torricelli**. Thank you, Dr. Rosen.

Mr. Del Balzo.

Mr. **Del Balzo**. Mr. Chairman, thank you very much. It's a pleasure to be back before this committee again today on the national civil tiltrotor initiative. I do have a full statement to introduce into the record, if you agree—

Mr. **Torricelli**. It will be entered into the record, Mr. Del Balzo, without objection.

Mr. **Del Balzo**. —and I will just take a few minutes to highlight some of the more important points.

I don't think there's any question that FAA continues to be optimistic about the potential benefits which a tiltrotor offers the National Airspace System and the country as a whole. And the list of benefits certainly include an increase in system capacity, increased productivity at congested airports in a way that will provide direct city-center to city-center transportation and improved efficiency in special applications and provide for U.S. penetration of the international market.

We began our initiatives back in the summer of 1988, and we did it for three reasons. First, our primary mission is to provide a safe and efficient aviation system and we believe that the tiltrotor has the potential to improve the efficiency of the airspace system while maintaining a high level of safety.

Second, we believe that tiltrotor technology can, in fact, be a viable means of intercity travel and we're committed to acting as a catalyst for the introduction of tiltrotor technology in the civil marketplace. Civil tiltrotor technology may well need promotion to overcome the natural reluctance to change and we're prepared to assist in that promotion.

Thirdly, our air traffic control, certification and regulatory responsibilities tell us that we need to ensure the safety of the tiltrotor from the drawing board to actual flight operations, not wait until it's ready for introduction into the marketplace, but get in on the ground floor.

We indicated to the chairman of the Subcommittee on Aviation in 1988 that we would be out front in leading the actions of both government and industry to facilitate implementation of the civil tiltrotor and I believe that we've been doing just that since the summer of 1988.

Our program is based on a five-point strategy for civil tiltrotor, and that strategy includes working closely with the Department of Defense and the V-22 program our R&D activities, increasing efforts in infrastructure, certification criteria and standards development. We formed the Civil Tiltrotor Special Project Office, as you know, and we have recently expanded the scope of that office to include helicopters and other power-lift aircraft as well.

We announced some goals, specific goals on a timetable. We had planned to certify a V-22 for demonstration purposes by 1992 and be ready to certify a civil design by 1995. Because of changes in the development schedule, our dates have slipped one year, but we still think that 1993 and 1996 is doable.

U.S. Government has invested over $2 billion in research and development. Most of that is military money. Our own FAA civil program was funded at approximately $9.5 million over the last two years. Add to that, just under $3 million for planning and feasibility studies of 17 vertiports.

I'd like to highlight some of the major accomplishments, as well as some of our projected activities. We're in the final stages of coordination on a rotorcraft master plan update and a civil tiltrotor program plan. We know it is that we want to do; we know how to do it, and we know how long it will take.

In conjunction with the results of the AIP grant studies, our plan is to help government and industry determine what the transportation requirements and needs are. We're engaged in a new study of transportation requirements and high-density intercity corridors. We're conducting a follow-up study to the joint FAA/NASA/DOD civil tiltrotor missions and applications study jointly funded by FAA and NASA, taking a very close look at technical requirements, the markets, the economics.

The Research and Development Advisory Committee has provided us guidance and recently formed the Tiltrotor Technology Subcommittee. That subcommittee was chaired by Norm Augustine, who has appeared before this committee earlier today.

The point is, if the tiltrotor is to become a reality before the end of this century, we must begin planning now for its certification. We're doing that. We must begin planning for a special infrastructure requirements. We're doing that, and we must be planning for an industry-based demonstration program to prove the concept and the aircraft's viability. We're prepared to do that.

Several areas of certification are unusual for the V-22 derivative tiltrotor. Take a lot of hard work and a lot of care, but I will tell you that we've committed additional resources to get this certification work accomplished in a timely manner.

There's no question that the introduction of civil tiltrotor into the civil airspace will require a change in the infrastructure. It will not be economically viable for the tiltrotor to enter into the air space if we're going to handle it like we handle a conventional airplane. We can't do that. The infrastructure has to be changed. We have some thoughts on how to do—on how to do that.

Those requirements are critical and it's very difficult to get potential operators and manufacturers to invest in tiltrotor technology if you don't have the facilities and the infrastructure in place. At the same time, it's difficulty to build vertiports until there are tiltrotors and operators wanting to fly into them. With the helicopter industry, I don't think there's any question that the lack of adequate landing facilities is the problem that they would most often cite as inhibiting operations and expanded service.

We must develop special enroute terminal airspace procedures for the tiltrotor, and we believe that there are promising technology available that allows us to do that. Probably the most significant application of technology to accommodate the tiltrotor in the civil airspace is the microwave landing system. It's tailor-made for tiltrotor operations, and the tiltrotor's full economic potential can't be realized if it's required to operate only in fixed-wing enroute and terminal air space by fixed-wing rules.

What we believe very strongly is that what's required is a successful demonstration program as part of a civil national tiltrotor program. Operators have to be convinced that the technology is safe, reliable, affordable and will operate as planned before a financial commitment is made.

Demonstration program will give us the opportunity to collect the technical and operational data. The demonstration program will be the proof, in fact, that you can fly city-center to city-center in less than 60 minutes and that the infrastructure can support it.

We're currently formulating criteria for such a demonstration program. It's not something that we can do alone. It requires a cooperative effort between the industry, the local governments and the Federal Government. There's no question in our mind that the demonstration program, a phased demonstration program, that can actually begin with V-22s that have been built as part of the military program, unpressurized in a cargo environment—we think that's a logical introduction of a demonstration program.

Witnesses before me have already made this committee aware of foreign interest in tiltrotor. There's no question that there is foreign interest and a concern that we should all have as a nation is that if we don't do it, somebody else will beat us to the marketplace.

Mr. Chairman, in view of the time, let me conclude my statement and I'd be happy to answer any questions that you might have at this time.

[The prepared statement of Mr. Del Balzo follows:]

STATEMENT OF JOSEPH M. DEL BALZO, EXECUTIVE DIRECTOR OF SYSTEMS DEVELOPMENT, FEDERAL AVIATION ADMINISTRATION, BEFORE THE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY, SUBCOMMITTEE ON TRANSPORTATION, AVIATION, AND MATERIALS CONCERNING THE CIVIL TILTROTOR INITIATIVE. July 17, 1990.

Mr. Chairman and Members of the Subcommittee:

It is indeed a pleasure to appear before you to discuss FAA's role in the National Civil Tiltrotor Initiative and to update for you the progress we have made since we last testified in November 1987 at a hearing held jointly by this subcommitee and the House Subcommittee on Aviation. Accompanying me today is Jim McDaniel, Acting Director of our Vertical Flight Program Office.

For Members of the Subcommittee who are not familiar with the tiltrotor, we are talking about an aircraft with the versatility to use on-airport vertiports that operate on a simultaneous but non-interfering basis with either commuter or jet traffic, or remove some of those passengers from the airport environment entirely -- to urban-center vertiports. The tiltrotor's strength is in its vertical take-off and landing capability. Its potential value to the national transportation system is as a turboprop airplane that does not need a runway.

We in the FAA remain optimistic about the potential benefits which the tiltrotor offers the National Airspace System and the country as a whole. These benefits include the potential to increase the system capacity, increase productivity at congested airports, provide direct urban-area to urban-area transportation, improve efficiency in special applications such as servicing the off-shore petroleum industry, rapid response in servicing oil spills, and provide for U.S. penetration of the international market for 20 to 75 seat commuter aircraft.

As you know, the National Civil Tiltrotor Initiative was established by the FAA in the summer of 1988. Our involvement is threefold. First and foremost, our primary mission is to provide a safe and efficient aviation system. We believe that the tiltrotor has the potential to improve the efficiency of the airspace system while maintaining our high level of safety. Secondly, if we ultimately decide that tiltrotor technology is a viable means of intercity travel, the FAA will act as a catalyst for the introduction of tiltrotor technology. Tiltrotor technology may well need promotion to overcome the natural reluctance to change -- change from the standpoint of modifying existing infrastructure as well as from accepting a dramatically new type of aircraft. Thirdly, our air traffic control, certification and regulatory responsibilities require us to ensure the safety of the tiltrotor from the drawing board to actual flight operations.

Since March 1988, when the FAA Administrator indicated to the Chairman of the Subcommittee on Aviation that the "FAA would take the lead," the FAA has been in the forefront of coordinating actions of both government and industry to facilitate implementation of the civil tiltrotor. (DOD is leading actual development of the military V-22 aircraft.)

Later in 1988, the agency announced its 5-Point strategy for civil tiltrotor, which included working closely with DOD and the V-22 program, increasing our R&D activities, and increasing efforts in infrastructure, certification criteria, and standards development. A Civil Tiltrotor Special Project Office was also established. Incidentally, we have recently expanded the scope of that office to include helicopters and other powered lift aircraft, in addition to tiltrotors. Renamed the Vertical Flight Program Office, it reports to me.

The agency also announced goals to certify a V-22 for demonstration purposes by 1992, and to be ready to certify a civil design tiltrotor by 1995. As a result of changes in the V-22 development schedule, our certification dates have slipped one year to 1993 and 1996, respectively.

To date, the U.S. government has invested over $2 billion in research and development for the tiltrotor, most of which is associated with military development. FAA's tiltrotor R&D is conducted as part of its rotorcraft program, which was funded at approximately $9.5 million over the last two years. In addition, we have awarded approximately $2.7 million in Airport Improvement

Program (AIP) Grants to fourteen sponsors for 17 vertiport planning and feasibility studies in response to our 5-Point strategy.

I would like to briefly review for you some of our major accomplishments and activities as well as projected activities. Currently, we are in the final stages of coordination with the Administrator on the Rotorcraft Master Plan update and a Civil Tiltrotor Program Plan. These plans delineate necessary actions to determine the role of civil tiltrotor service in the national airspace system. In conjunction with results of the AIP grant studies, the Civil Tiltrotor Program Plan will help government and industry determine what the transportation requirements and needs are. In addition, the Department of Transportation is engaged in a new study of transportation requirements in high-density intercity corridors. Tiltrotor service will be one of the transportation options under study. The AIP studies will provide insight into short-haul systems with a different, regional insight, and provide data for future planning. Another significant activity is the development by our Rotorcraft Directorate of interim-powered lift criteria, which is being used for certification planning by manufacturers in developing a civil tiltrotor.

We are also conducting a follow up to the 1987 FAA/NASA/DOD Civil Tiltrotor Missions and Applications Study. Jointly funded by the

FAA and NASA, the follow-on study will provide a more detailed analysis of the technical requirements, markets, economics, and other areas addressed in the first report. The results of that study are due next month.

Our Research, Engineering and Development Advisory Committee, which provides advice and guidance to the Administrator on FAA programs, has recently formed a Tiltrotor Technology Subcommittee. Norman Augustine, CEO of Martin/Marietta Corporation, has accepted the chair of the new subcommittee, and Jim McDaniel will be serving as the executive secretary. The first subcommittee meeting was held June 4-5. This meeting dealt with an overall program review and the response to a Department of Defense request for FAA to provide information requested by the Senate Armed Services Subcommittee. The Senate Armed Services Subcommittee has requested Secretary of Defense Cheney, in conjunction with the Department of Transportation and the FAA, to examine key questions concerning capacity impacts, foreign potential, and industry actions toward a civil version of the V-22 tiltrotor. We are supporting DOD, and a coordinated response will be available this summer.

If tiltrotor is to become a reality before the end of this century, we must begin planning now for its certification, its special infrastructure requirements, and an industry-based demonstration program to prove the concept and the aircraft's viability.

Several areas of certification are unusual for the V-22 derivative tiltrotor, including extensive use of composite materials, glass cockpit, fly-by-wire control systems and the software redundancy problems they pose, extensive use of automation, extremely high pressure hydraulic systems, and the tilting nacelles and proprotors which are unique to the tiltrotor. We have committed additional resources to get this certification work accomplished in a timely manner.

Infrastructure requirements for tiltrotor operations include the design and construction of vertiports, which are heliports designed to accommodate a commercial tiltrotor; communications, navigation, and surveillance systems; terminal instrument procedures (TERPS) development; and ATC enroute and terminal airspace and procedures development that will allow simultaneous and non-conflicting operations with fixed-wing aircraft in high-density areas. Of course, one must address the noise issues implicit in the technology for its effects around an airport. Preliminary information indicates that tiltrotors should meet Stage 3 noise requirements. The aircraft will be quieter than a helicopter in vertical operations and quieter than most turboprops in level flight.

Infrastructure requirements are critical, since it is difficult to get potential operators and manufacturers to invest in tiltrotor technology when there are no established facilities (vertiports) for tiltrotor operations. Conversely, it is difficult to build vertiports until there are tiltrotors and operators wanting to fly into them. For the helicopter industry, the lack of adequate landing facilities is the problem most often cited as inhibiting operations and expanded service.

On the FAA side of the ledger, we must develop special enroute and terminal airspace procedures for the tiltrotor. We believe, however, that the most promising precision navigation and landing system for the tiltrotor is the microwave landing system (MLS). Because of its capabilities for curved approaches, segmented glide paths, and offset approaches, MLS appears tailor-made for tiltrotor operations. It is important to emphasize that the tiltrotor's full economic potential cannot be reached if it is required to operate only in fixed-wing enroute and terminal airspace, and by fixed-wing rules.

We believe that a successful demonstration program should be an important part of our civil tiltrotor program. Prospective operators must be convinced that the technology is safe, reliable, affordable, and will operate as claimed before a financial commitment is made. A demonstration program would afford us the opportunity to collect vital technical and operational data, and to test the tiltrotor concepts of non-interfering airspace structure and any necessary modifications to air traffic control procedures. Secondly, a demonstration program would allow us the opportunity to make necessary refinements to enhance safety and test our ideas for improving capacity.

It is important to stress at this juncture that the FAA's role in any demonstration program is limited to certifying the aircraft and flightcrews, planning, providing necessary infrastructure support and airport grants, data collection, and maintaining coordination between industry and government. The actual conduct of the demonstration is an industry or a state or local government responsibility. We do not consider it an appropriate FAA role to actually conduct demonstration programs.

We are currently formulating criteria for a demonstration program. The demonstration will require a cooperative effort between industry, local governments, and the Federal government. It would provide vital data to government and industry in the areas of tiltrotor safety, reliability, training, maintenance, economics, environmental concerns, and operational scenarios. The demonstration program may include more than one element, with the first "phase" possibly being conducted in a relatively "low-density", less congested environment such as in Alaska, or perhaps the Caribbean Basin, with a follow-on phase in a more complex, congested area of the United States after the more basic operational aspects are evaluated. The follow-on phase would concentrate on integrating tiltrotor operations into the national airspace system, and would look specifically at both enroute and terminal ATC routing and procedures, terminal instrument procedures, aircraft operating characteristics, schedule reliability, public acceptance, and physical vertiport needs.

Our initial thinking for a demonstration is centered on air cargo operations. While a passenger commuter demonstration in a highly congested area would be ideal, it is not likely because of the more stringent certification requirements needed to carry revenue passengers. Also, as an unpressurized aircraft, the V-22 would be forced to remain at a lower than optimum altitude, and likely would not produce accurate data for evaluating later commercial tiltrotor operational profiles, economics, or passenger acceptance.

Before closing, the Subcommittee should be aware of foreign interest in tiltrotor. There are three foreign groups with interest in high speed, vertical flight aircraft. The first, the Europeans, have been interested in the tiltrotor for several years, and are in the final stages of studying its feasibility. They have developed a five-country consortium called "EUROFAR", which stands for European Future Advanced Rotorcraft. They have not committed to build an aircraft to date, but their study results closely parallel ours, and in a number of areas have actually validated our 1987 study results. The Europeans are following V-22 closely, and project 1991 to start development of their own tiltrotor, with commercial service beginning around the end of the century. They have also identified 50 percent of their market potential as being in the United States.

The Japanese are very interested in tiltrotor, and have contracted with a Texas firm to build a tiltwing aircraft designated the TW-68. They have reportedly committed funding to complete FAA certification of their tiltwing, and have stated their intention to beat an U.S. tiltrotor to commercial production. The Japanese Ishida Corporation has recently purchased land and has begun facility construction at the Alliance Airport in the Dallas/Fort Worth area, and intends to develop and manufacture the TW-68 there. The TW-68 will carry 12-14 passengers, which makes it smaller than the V-22, and slightly larger than the XV-15. Private interest in Japan are also planning to develop a series of heliports, many of them on water, and are counting on high speed vertical flight aircraft to help relieve their pending transportation crisis.

The Soviets have admitted an interest in tiltrotor technology and conducted some development work, but have not offered further specifics.

Even if an American tiltrotor is not built and a foreign made tiltrotor was imported, the FAA would still be required to perform the necessary certification and infrastructure functions. Regardless of who builds the tiltrotor, the FAA still has the responsibility to provide for "a safe and efficient aviation system," and we would still have to certify it and accept it into the national airspace system.

Mr. Chairman, the FAA believes that tiltrotor has potential to significantly improve air transportation services to city centers and to reduce airport congestion through low-cost, vertiport facilities operating independently of conventional air traffic at major airports. Tiltrotor technology also has potential to improve transportation services in remote areas of the United States, such as Alaska, and lesser developed nations of the world.

We believe that the civil tiltrotor program is fully consistent with the President's National Transportation Policy, in that the proposed demonstration program will support an assessment of a major new technology proposed for intercity transportation. The results, including independent analysis of market viability and environmental acceptability, can provide America's entrepreneurs the necessary information to decide whether commercial tiltrotor will play the important role we envision in the national transportation system. In the long term, the results of these initial efforts will be available to support sound decision making by industry and government. The nation has invested heavily in the R&D of this technology for defense, and we are fortunate to have the opportunity to test, demonstrate, and validate its applications to the civil sector.

Mr. Chairman, that concludes my prepared statement, and I would be happy to answer any question you or other Members of the Subcommittee may have.

Mr. **Torricelli**. Mr. Del Balzo, thank you very much. Thank you, each, for your testimony.

Mr. Del Balzo, we agree, then, that providing separate air space, something outside of the current air traffic control system, is what is necessary as part of infrastructure development for tiltrotor?

Mr. **Del Balzo**. Absolutely.

Mr. **Torricelli**. That point is no longer even being debated within the FAA. We share the concept.

Mr. **Del Balzo**. Yes, sir.

Mr. **Torricelli**. What is your view of the need for a civil demonstration program, such as Mr. Horner of Bell outlined earlier?

Mr. **Del Balzo**. I think it's critical. I think we, as a nation, and the aviation business, need proof of concept. I think we operate in aviation—

Mr. **Torricelli**. So we share a view that absent a civilian demonstration project, this simply is not likely to happen.

Mr. **Del Balzo**. I agree.

Mr. **Torricelli**. Is DOT, in either of your judgments, the appropriate place for this to take place?

Mr. **Del Balzo**. I think DOT is the appropriate place to be a partner and manage a demonstration program, yes, sir.

Mr. **Torricelli**. Mr. Rosen.

Mr. **Rosen**. Well—

Mr. **Torricelli**. Are you longing to be back in the business?

Dr. **Rosen**. I could tell you where it shouldn't be and I don't think it's appropriate for NASA to lead a demonstration. I think—

Mr. **Torricelli**. Why is that? You seem to have a lot of people who share that judgment. Why?

Dr. **Rosen**. Well, we do some things well and there's other things we don't know how to do and I think running a demonstration program is something that we really wouldn't—we don't have any experience in and wouldn't have any particular expertise and, therefore, somebody else probably ought to do it.

We also have other responsibilities and I'd hate to see the two conflict.

Mr. **Torricelli**. The focus of FAA R&D funding, as I understand it now, is virtually all in the certification side of this. Is it not appropriate that the FAA itself begin working on the questions of the infrastructure, such as terminals and landing facilities?

Mr. **Del Balzo**. I think it is appropriate and I think you will find a heavy investment on the part of FAA in developing, one, infrastructure requirements, certainly developing the requirements and criteria for a vertiport providing a design guide to those operators and communities that are interested in building rotorports. You will see a commitment on the part of FAA to provide financial support for the planning studies associated with the location of vertiports—

Mr. **Torricelli**. This is, of course, what we've required in our authorization bill, but—

Mr. **Del Balzo**. Yes, sir.

Mr. **Torricelli**. —absent the fact that we're requiring it, we seem to have the same thinking in any case.

Mr. **Del Balzo**. Yes, sir, we do.

Mr. **Torricelli**. The concept that was discussed earlier of what these vertiports might look like, numbers of aircraft, it was suggested—I'm not talking about now of dedicated areas of existing airports, but the separate sort of West Side, Hudson River Pier operations. They were envisioned of being three and four acres—

Mr. **Del Balzo**. Yes, sir.

Mr. **Torricelli**. —for four-aircraft to operate off of. Is this a concept—is this a similar concept of the thinking of the FAA at the moment?

Mr. **Del Balzo**. Yes sir. Three to four acres.

Mr. **Torricelli**. And numbers of aircraft?

Mr. **Del Balzo**. Four, five.

Mr. **Torricelli**. Did you also share the concept of adjusting the market economics so as to make this relatively less expensive and short-distance fixed aircraft that are in competition relatively more expensive to help move the economics?

Mr. **Del Balzo**. I'm not prepared to comment on that question.

Mr. **Torricelli**. Okay.

Mr. **Del Balzo**. I Don't know.

Mr. **Torricelli**. Tell me about your judgments on noise and safety as compared with current fixed-wing and helicopter aircraft, either of you, from your—your experiences.

Mr. **Del Balzo**. I think on the safety question, we would ensure through our certification procedures equivalent to or better than the safety of existing aircraft. From the noise standpoint, I think we can do better, but the numbers that I have seen tell me today that a tiltrotor will be more quiet than the quietest helicopter and—

Mr. **Torricelli**. You are believing that and you're accepting—

Mr. **Del Balzo**. Yes, sir, I do. Yes.

Mr. **Torricelli**. Now, is that—is that also because of the flight characteristics of—it is simply removed from people's way faster or is it also because the engines are operating with less noise?

Mr. **Del Balzo**. I think both. The equal—

Mr. **Torricelli**. So even if this were not with the kind of flight patterns we envisioned, that it simply gets out of the way faster, even if that were not the case, it would have noise advantages?

Mr. **Del Balzo**. It would have noise advantages, yes, sir.

Dr. **Rosen**. If I can—if I can add to that, the characteristics of the tiltrotor are such that they really would have a noise advantage over a helicopter. In a lot of considerations, a lot of cases, and over a turboprop in others.

The size of the rotors are such, and they turn slower, the loading is less so that they're going to be quieter in forward flight. When you get to the takeoff—well, they also, in forward flight, won't have anything like the noise of a helicopter because they're not flying through their wake. It's a conventional aircraft.

With respect to takeoff, they also are lower noise than a helicopter because of the flight paths. So overall, both in comparison with a fixed-wing and comparison with a helicopter, I think it's a quieter aircraft.

Mr. **Torricelli**. Dr. Rosen, you were not exactly aggressive in promoting the future role of your own organization in this development in the future, but now, in retrospect, as you look back at the

XV-15, did it—was it a worthwhile thing to do, appropriately placed in NASA? Has it played an important role in bringing us to this point?

Dr. ROSEN. I think, Mr. Chairman, that we were very aggressive in that phase of the program—

Mr. TORRICELLI. I wasn't commenting on that. I was—

Mr. DEL BALZO. —and that is the right nature and character of the work that NASA should be doing.

Mr. TORRICELLI. So it was a worthwhile investment and experience and NASA was the right place to do it?

Dr. ROSEN. Without a doubt.

Mr. TORRICELLI. Mr. Del Balzo, is the timing of our shared interest in a air space and a terminal infrastructure development concept within FAA—we have in our authorization bill a requirement for next year—you're proceeding at your own pace in any case. When can potential users, carriers, passengers and manufacturers have evidence of your thinking?

Mr. DEL BALZO. Two years, based on the results of analytical studies and simulations that we would have conducted. Obviously, we can't demonstrate in an operational environment, but based on analysis and simulations, two years.

Mr. TORRICELLI. Regardless of what happened to the V-22 vote, based on the prototypes that now exist—

Mr. DEL BALZO. I believe—

Mr. TORRICELLI. —and their experience?

Mr. DEL BALZO. —that that's a schedule that we would hold to anyway.

Mr. TORRICELLI. In any case?

Mr. DEL BALZO. Yes, sir.

Mr. TORRICELLI. Well, that's an appropriate note on which to end, because although we will gather many times within the two years, in two years, we will also gather to receive that analysis.

Gentlemen, this has been very helpful. It certainly has helped me as we consider legislatively how to move this process along to encourage this development, as I think it also contributes to the discussion on the V-22 debate.

Mr. Del Balzo, thank you for coming back again, for one of your many visits before the committee. Mr. Rosen, thank you very much for being with us as well.

[The prepared statement of Mr. Augustine follows:]

STATEMENT BY
NORMAN R. AUGUSTINE
CHAIRMAN OF THE TILTROTOR TECHNOLOGY SUBCOMMITTEE
OF THE FAA RESEARCH, ENGINEERING & DEVELOPMENT
ADVISORY COMMITTEE

TO THE
UNITED STATES HOUSE OF REPRESENTATIVES COMMITTEE
ON SCIENCE, SPACE AND TECHNOLOGY SUBCOMMITTEE
ON TRANSPORTATION, AVIATION, AND MATERIALS

JULY 17, 1990

WASHINGTON, D. C.

Thank you, Mr. Chairman and members of the Committee, for this opportunity to share with you the views of the Tiltrotor Technology Subcommittee of the FAA Research, Engineering and Development Advisory Committee. The views I shall present are my attempt to reflect the subcommittee's findings as approved by the parent committee; however, due to the limitation on available time, neither of these groups has specifically approved my statement. Similarly, the views expressed have not been formally reviewed by the FAA and of course do not represent a statement of the Agency but rather the opinions of members of an outside, independent advisory group. The subcommittee's final report is scheduled to be submitted to Admiral Busey later this week.

Your letter of invitation dated June 27, 1990 requested that I specifically address four subjects, and I shall be pleased to do so. The first of these concerns the current status of the civil tiltrotor program.

When I initially accepted the chairmanship of the tiltrotor task group for the Federal Aviation Administration, I had assumed I would be able to use my aeronautical engineering background to address the issues affecting this aircraft. However, the subcommittee soon found that the real issue being faced is a transportation system problem and that the development of the aircraft itself, the V-22 Osprey, was a program embodying normal engineering risk and generally progressing satisfactorily in its final engineering and test phases. In short, although there are technical challenges yet to be met, none appear to lie outside the current state of engineering knowledge nor are they viewed as particularly formidable.

Our committee did not investigate the military requirements for the program, in that this is of course a DoD responsibility. As you are aware, the Department of Defense (OSD) had cancelled the program in 1989; however, development continued in 1990, with Congressionally mandated funds. The Department of Defense has not requested Fiscal Year 1991 funding so far as we know.

Simply stated, there does not appear to be any degree of abnormal risk associated with the remaining development of a tiltrotor aircraft, even somewhat in excess of the 40,000 pound Osprey class.

The second area you requested be addressed relates to the benefits of a civil tiltrotor transportation system.

The problem of air and ground transport congestion is indeed serious today and will undoubtedly continue to escalate in the future. It is projected that by the year 2000, eight out of every ten passengers will be inconvenienced by airport congestion. By that time, demand will approach double today's level. There are no apparent, readily available, or currently acceptable solutions which the committee was able to identify.

The commercial tiltrotor has been proposed as one emerging technology with a high potential to increase the aviation system's capacity and help relieve airport congestion. Commercial tiltrotor commuter aircraft can in fact alleviate the strain on airports and airways by replacing many of the small capacity, short-range conventional fixed wing commuter aircraft in a manner which largely eliminates demands they now place on existing, heavily burdened channels of operation. Tiltrotor aircraft can, for example, land at vertiports co-located at a conventional airport, yet operate simultaneously and relatively independently from standard fixed wing traffic.

For many flights, tiltrotors will not need to land at conventional airports at all, but rather will operate directly from the urban areas being served -- the desired origin and destination of many passengers -- at urban center or city-center vertiports. The conventional runway slots thereby opened can either be used to reduce congestion or to serve larger fixed wing aircraft traveling greater distances, thereby increasing system capacity. The consequent increase in the average number of passengers per conventional aircraft arrival or departure can be converted into direct revenue increases for the carrier airlines and increased convenience for the passengers.

The third area you requested we address concerns the degree to which additional research is required to ensure a viable civil tiltrotor fleet (technology, air traffic control procedures, infrastructure requirements, etc.)

For a civil tiltrotor system to achieve its potential, a new air traffic management approach will need to be adopted. In congested terminal airspace, tiltrotor departures and arrivals must be separated from fixed wing traffic so that tiltrotors do not simply occupy the same "slots" on the runway or the same airspace during sequencing as do fixed wing aircraft. En route, tiltrotor flights need to be reasonably direct, to maximize their time-saving advantage.

Tiltrotors generally will need to operate to and from vertiports designed for commercial tiltrotor operations. These facilities would include on-airport vertiports, urban-area or city-center vertiports (off airport), smaller rural-area vertistops, and some fixed runways.

Concerns over civil applications center primarily around economics and the adaptability of aviation system infrastructure. Essentially the hurdle that faces civil tiltrotor is an overall "systems" problem of getting all the pieces to come together -- and this is proving to be challenging indeed.

First and foremost, potential future buyers and operators of civil tiltrotors seek to be convinced that the technology and economics are viable before they will commit funds and place orders for aircraft representing such a departure from conventional practice. Without extensive technical and operational data to draw upon, as would have accrued with DoD procurement and operation of the V-22 accompanied by a civil demonstration program, U. S. operators do not appear likely to buy tiltrotors in the foreseeable future. A demonstration program is therefore absolutely essential to provide needed technical and operational data if the civil tiltrotor project is to become an operational reality.

The difficulty resides in identifying a mechanism in the current U.S. economic system to implement the needed demonstration and gain the confidence of aircraft industry, government, and operators. In short, American developers appear unlikely to conduct a demonstration without first having order commitments from aircraft operators. Aircraft operators, in turn, are unwilling to commit to the purchase of fairly revolutionary new aircraft without greater understanding of their operational economics and reliability, along with assurance that needed (vertiport) facilities will be available. Operators of airport facilities, in turn, are unwilling to commit to reasonably costly new capabilities until it is clear that there are aircraft and passengers who are prepared to use them.

The viability of a commercial tiltrotor therefore depends first and foremost upon the creation of a viable demonstration program.

The final area you asked be addressed is the degree to which additional research is currently underway or planned.

The questionable status of the Osprey program, now in its second particularly tenuous year, debilitates the opportunity of conducting a civil demonstration program. Although civil payoff from a defense demonstration program would be significant and welcomed, it is the view of the committee that the development of civil needs should not in themselves be the underlying justification for DoD's conduct of a program.

Many alternatives exist depending on whether the Osprey program is cancelled, continued in R&D or pursued into full-scale production by the Department of Defense. The delay in the civil program of course continues as it awaits these decisions, although there are in fact useful actions that can and (some) are being undertaken in preparation for the arrival of this or any other vertical flight technology aircraft. These include noise abatement studies, aircraft size tradeoffs, passenger acceptance evaluations, certification of aircraft and crews, en route and terminal procedures development (air side), heliport/vertiport construction criteria preparation (ground side), interface with existing air and ground transport systems, etc.

The Tiltrotor Technology Subcommittee concluded that the requirement for civil applications for tiltrotor technology is real; that the necessary aircraft technology is available at reasonable risk; that the requirement for a system and infrastructure is understood; and that an operational demonstration program is lacking and thereby comprises the principal impediment to civil tiltrotor application in the U.S.

It is, we believe, worthy of note that the problems faced by the Civil Tiltrotor program are not particularly unique. In fact, there is a much broader problem extant in America today. In the past the defense budget was frequently the source of critical technological advancements which opened major new commercial markets for American firms (spacecraft, jet aircraft, and semiconductors and computers are among these). With significantly declining resources available for defense, this is much less likely to be the case in the future. Yet, in America we have no real mechanism to support the development of promising but long-term, at least moderate risk, high entry cost technological undertakings. Private capital is simply too scarce and too impatient for most such pursuits. This of course contrasts sharply with the situation in most other major industrialized nations where partnerships between government and industry have evolved not only in the military but also in the civil arena.

This, Mister Chairman and members of the Committee, is the true underlying problem that the members of the Tiltrotor Subcommittee believe must be addressed -- not the features of a particular aircraft.

And with the Committee's permission, if I might close by respectfully sharing a personal experience relating directly to the subject matter at hand: this testimony was largely prepared while your witness waited on the ramp at Newark Airport for 3-1/4 hours to take off on a one-hour flight to Washington, D.C.

Again, on behalf of the FAA Tiltrotor Technology (Advisory) Subcommittee, we thank you for this opportunity to share some of our views with you. I truly regret that I was unable to appear in person to answer your questions and do appreciate your understanding of a long-standing commitment which precluded my being present.

NORMAN R. AUGUSTINE was born in 1935 in Colorado and attended Princeton University where he majored in Aeronautical Engineering, was awarded a BSE magna cum laude, an MSE, and was elected to Phi Beta Kappa, Tau Beta Pi and Sigma Xi. He holds Honorary Doctor of Engineering Degrees from Rensselaer Polytechnic Institute and Western Maryland College, and an Honorary Doctor of Science Degree from the University of Colorado.

In 1958 in California he joined the Douglas Aircraft Company where he held titles of Program Manager and Chief Engineer. Beginning 1965, he served in the Pentagon in the Office of the Secretary of Defense as an Assistant Director of Defense Research and Engineering. Joining the LTV Missiles and Space Company in Texas in 1970, he served as Vice President, Advanced Programs and Marketing. In 1973 he became Assistant Secretary of the Army and in 1975 Under Secretary of the Army. Joining Martin Marietta Corporation in 1977, he has been Chairman and Chief Executive Officer since 1987, having previously served as President and Chief Operating Officer.

Mr. Augustine is chairman of the Defense Policy Advisory Committee on Trade (DPACT), has served as president of the 40,000-member American Institute of Aeronautics and Astronautics of which he is an Honorary Fellow; as president and as chairman of the 160,000-member Association of the United States Army; chairman of the Aeronautics Panel of the Air Force Scientific Advisory Board; chairman of the Defense Science Board; chairman of the NASA Space Systems and Technology Advisory Committee, and as a member of the NASA Advisory Council. He has been elected to the National Academy of Engineering and the International Academy of Astronautics of which he is a Trustee, is an Honorary Fellow of the Society for Technical Communications, a Fellow of the American Astronautical Society and a Fellow of the Institute of Electrical and Electronic Engineers. He is a licensed professional engineer in the State of Texas.

He is a member of the Board of Directors of Phillips Petroleum Company, Procter & Gamble Corporation, the Riggs National (Bank) Corporation, the Ethics Resource Center, the Atlantic Council and the Wolf Trap (National Park) Foundation, and has served on Boards of the Colorado National Bank, Hoskyns Group plc of the U.K. as chairman, the American Helicopter Society, the American Productivity Center, the Air Force Academy Foundation, and the Research Triangle Institute. He has been on advisory boards to the White House, the U.S. Senate, NASA, the FAA, and the Departments of Defense, Army, Navy, Air Force, Energy, and Transportation, the General Accounting Office, and NATO. He is a member of the President's National Security Telecommunications Advisory Committee, the Chief of Naval Operations' Executive Panel, the Policy Council of the Business Roundtable, the Council on Competitiveness, The Business Council, and the Conference Board, and is a Member of the Corporation of the Draper Laboratory , a Principal of the Council for Excellence in Government, and a member of the Board of Governors of the Aerospace Industry Association. He is a Trustee of The Johns Hopkins University, an Honorary Member of the Faculty of the Industrial College of the Armed Forces and a member of the Advisory Council of the School of Medicine at Johns Hopkins. He has chaired advisory councils for Princeton University, the American University, the University of Maryland and the MIT Lincoln Laboratory, and served on advisory boards for the University of Colorado, Georgia Tech, Duke, Texas A&M, USC, Johns Hopkins, Florida State, the Defense Systems Management College, and the National Defense University, where he was a Bernard Baruch Lecturer. He has been an Associate Editor of the *Defense Systems Management Review* and served on the Editorial Boards of *Astronautics and Aeronautics* and the *Journal of Defense Research.*

He has four times been awarded the Department of Defense's highest civilian decoration, the Distinguished Service Medal, and has received the Defense Meritorious Service Medal, the Army Distinguished Service Medal, and the Air Force Exceptional Service Medal. He is a recipient of the National Security Industrial Association's James Forrestal Memorial Award, the American Astronautical Society's Military Astronautics Trophy, the American Institute of Aeronautics and Astronautics' Goddard Medal, the Association of the United States Army's Distinguished Service Award, the American Defense Preparedness Association's Gold Medal and Knowles Award, the Society of Manufacturing Engineers' Gold Medal, the Industrial College of the Armed Forces' Eisenhower Award, the National Contract Management Association's Roback Award, the Armed Forces Communications and Electronics Association's Sarnoff Award, the Institute of Electrical and Electronics Engineers' Carlton Award, the Colorado ARCS Man of Science Award, the Boy Scouts Citizen of the Year Award, the Harvard Business School Club of Washington Business Statesman Award, and is an Honorary Command Sergeant Major of the U.S. Army.

Mr. Augustine is vice president of the Boy Scouts of America and has served on a state board of the minority INROADS program. He is married to the former Margareta Engman of Stockholm, and they are the parents of a son, Gregory, who is an electrical engineer, and a daughter, Rene', who is an attorney. He is author of the book *Augustine's Laws*, printed in English, German and Italian, and soon in Russian. He holds a copyright on a calculator for baseball managers, and is listed in *Who's Who in America* and *Who's Who in the World.*

6/14/90

Mr. **Torricelli**. The committee stands adjourned.

[Whereupon, at 4:45 p.m., the subcommittee was adjourned, to reconvene subject to the call of the Chair.]

○